THE SOIL SCIENCE SOCIETY OF FLORIDA

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PROCEEDINGS
VOLUME IV-A
1942

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Interim Meeting of the Society
West Palm Beach
April 21, 1942

Reclamation and Soil Conservation Problems of the Florida Everglades

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ACKNOWLEDGMENTS

Again we are deeply indebted to the Officials of the Florida State Horticultural Society for their cordial cooperation in developing an Interim Meeting of our Society simultaneously with their Annual Convention in April, this time on the important question of Everglades development. The excellent attendance and the intense interest displayed in the program throughout the day by all present is a satisfactory indication of the merit and success of the conference.

It is a particular pleasure to acknowledge the attendance upon these meetings of the Commissioner of Agriculture, the Honorable Nathan Mayo and his associates, Mr. Herman Gunter, State Geologist, and Mr. F. E. Bayless, Head of the Land Office. Their continued interest in an important, public problem of this nature cannot but mean a great deal to the progress of its solution in the future and, consequently, to the welfare of the whole State.

We are also indebted to the Officials of the George Washington Hotel for their courtesy and efficient handling of the varied needs of the group throughout the day.

In view of the fact that it has been found necessary to finance the publication of a special proceedings of this nature by voluntary contributions, we are especially obligated to those individuals and organizations, listed below, who have given us outright donations or taken out sustaining memberships in the sum of ten or twenty-five dollars specifically for this purpose.

Florida Department of Agriculture, Tallahassee
Everglades Drainage District, Clewiston
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DEDICATION

THE HONORABLE SPESSARD L. HOLLAND
GOVERNOR OF FLORIDA

There can be no question in the minds of those who know of the fine way in which Governor Holland handled the refinancing of the Everglades Drainage District during the past few months as to the great indebtedness of all Florida to him on this account, even though it is but typical of the complete and statesmanlike manner in which he has worked and is working in leading our State through one of the most difficult periods of its entire history. If this highly important contribution to the reorganization of the affairs of the District can be followed up sharply with a physical plan of conservation and development for the Everglades area that is flexible and adequate from every standpoint, that gratitude indeed will assume enduring proportions since it can then face the future fully and completely geared to a wonderfully productive land that has been made everlasting in its physical usefulness with the help of his industrious and farseeing efforts.

The Soil Science Society of Florida is deeply honored for the privilege of dedicating this special section of its Fourth Proceedings, covering a discussion of certain physical and economic aspects of our Everglades problems to his Excellency, the Governor, and takes this opportunity to wish him Godspeed in a career of public service that already is so well known for the personal integrity, the constructive thoroughness, and the whole-hearted unselfishness upon which his brilliant administrative accomplishments are based.

HONORABLE SPESSARD L. HOLLAND

GUEST SPEAKER

THE HONORABLE NATHAN MAYO
COMMISSIONER OF AGRICULTURE

Mr. Mayo's unselfish devotion to the agricultural welfare of Florida is too well known to profit by an itemization of his public deeds in any form or their description to any extent. There is scarcely a phase of the complex agricultural development of the State that has not felt, and profited by, the impact of his personal industry and interest.

It was indeed fortunate for our conference that Mr. Mayo could find it possible to be present. Speaking for the State, both as the personal representative of the Governor and as a Trustee of the Internal Improvement Fund, his acknowledgment of the Everglades problem and promise of every assistance the State can render in its solution are stimulating from a number of standpoints. More than this, his candid request for assistance in any form and from any source, in attacking this problem constitutes a wholesome challenge to the Federal, State, and local agencies working on it and to the Soil Science Society of Florida which cannot possibly be ignored.

Mr. Mayo's viewpoint and opinion on the subject are contained in an extemporaneous address made during the morning hours of the discussion that appears on pages 11 to 13 of this Proceedings and in his closing remarks in the course of the general discussion to be found on page 118.

HONORABLE NATHAN MAYO

Reclamation and Soil Conservation Problems of the Florida Everglades

A. THE PHYSICAL PHASE

INTRODUCTION

J. R. NELLER,* *Chairman*

Man's alteration of the physical characteristics of a region almost always results in problems relating to the utilization or conservation of that area. Thus, deforestation causes excessive and too rapid runoff from watersheds with soil erosion, river floods and silting as a result. Irrigation and cultivation of arid lands often bring about an accumulation of salts from irrigation waters as well as loss of soil organic matter. Drainage of peat and muck lands has almost always resulted in too low a water table or over-drainage with resultant excessive soil oxidation and subsidence.

Over-drainage has occurred on most peat and muck reclamation projects and the Everglades is no exception to what has taken place on other organic soil areas. The Everglades is unique, however, in that it is one of the largest of peat soil areas and probably the most valuable. Its location in a subtropical zone causes its soils, when unduly exposed, to be subject to excessive oxidation losses.

Realization of the importance of conserving the Everglades has resulted in a considerable number of directed studies and surveys by state, private and federal agencies relating to soils, geology, engineering, land ownership and taxes. The establishment of the Federal dike around the south end of Lake Okeechobee and the improvements of the Atlantic and Gulf outlets of the lake form a basis for the water control which we now know is essential to soil conservation. The resulting increased profitable use of Everglades lands has made possible the refinancing of the Everglades Drainage District. We all know that this is an important development for the clearing of land titles, etc.

But these improvements are by no means sufficient. Unused areas in the Everglades continue to be wasting at an alarming rate. Moreover, the continual bringing in of new land under water control for farming is creating a situation in which the existing drainage canals will soon be inadequate to dispose of water during periods when it is present in excess.

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* President of the Society. Biochemist at the Everglades Experiment Station, Belle Glade, since 1930; in charge since 1937. Formerly Research Assistant at the Minnesota and New Jersey Agricultural Experiment Stations and subsequently Research Chemist for the Texas Company and the Washington Agricultural Experiment Station. Doctor Neller has investigated sulfur deficiencies of western soils; use of chemicals for weed eradication and for removal of spray residues; physiological effect of soil treatment; oxidation and associated volume change of peat soils in relation to ground water level and soil wastage; also fertilizer usage on peat soils with reference to assimilation by plants, fixation, and loss by leaching.

In other words there is danger that a drainage district or farm will be pumping water which may break through dikes onto another district or farm which is itself striving to dispose of water.

There is urgent need, therefore, for a year round definite functioning of an organization vested with the authority to direct a planned development of the farmed area of the Everglades and to supervise the water control of the region. This job would have been much simpler if the reclamation of the Everglades had been started under a planned program of that nature. Thus, of the 550,000 or more acres of land that have good agricultural value about 95,000 acres are already being farmed. These farmed areas are in scattered locations mostly along the canals and about the Lake in the upper Everglades and since the private ownership of lands is still more scattered the continual development of new lands is aggravating the problem.

Investigational work in the Everglades has shown that maintenance of soil water tables at as high a level as possible provides the only means of conserving the soil of the area. The water resources study of southern Florida indicates that the establishment of more definite soil water levels will conserve and guarantee the municipal water supply for the lower East Coast.

Water control, therefore, appears to be the key to the whole problem. This embraces the inflow into the lake as well as the flow from the lake and from the Everglades itself. As already mentioned the control of the waters of this great area needs to be administered by a governing body whose regulatory activities should be prompt and effective and based upon recommendations of expert and well informed advisors.

These factors have been investigated and studied to a considerable extent, especially during the past decade. They are to be discussed today by a group of men who have given years of study to the various phases of the problems of the Everglades and who will present the matter to us in a logical way. I would like to let you in on a little secret about this meeting. It is that the conservation of the soil and water resources of the Everglades is considered so important and so pressing that the participants in this program got together a few weeks ago and spent a whole day in comparing notes relative to their data.

As a conseqence you will note that there is a logical sequence of presentation starting first with the physical characteristics of the Everglades and the changes that drainage has brought about.

These papers will be followed by a discussion this afternoon dealing with land ownership, drainage districts and taxation and the relation of these factors to a plan of reclamation whereby the vast and valuable resources of the Everglades can be conserved and utilized to the fullest possible extent.

The first of these discussions will deal with "The Principal Characteristics of the Kissimmee-Everglades Watershed from the Hydrological Standpoint" by C. C. Shrontz and J. C. Stephens. Before entering upon the regular program, however, we would be glad to hear from the Commissioner of Agriculture, the Honorable Nathan Mayo, who has found it possible to be with us today. Mr. Mayo, we all know of your long time interest in the Everglades and will be very glad for any remarks you may care to make. Ladies and Gentlemen, Mr. Mayo.

THE RESPONSIBILITY OF THE STATE

(An extemporaneous address)

THE HONORABLE NATHAN MAYO

Mr. Chairman, Ladies and Gentlemen:

I bring you greetings from Governor Holland and all the other members of his cabinet and especially from the members of the Internal Improvement Board who are vitally interested in all phases of the Everglades problem which are to be reviewed here today.

I bring you especial greetings from Mr. Fred C. Elliot; also his sincere regrets at being unable to be with you. Mr. Elliot wanted very much to be here today since he has been deeply interested in the problems of the Everglades ever since the inception of its development, to such an extent, in fact, as most of you well know, that it has all but become a part of him. But Mr. Elliot is a very busy man right now, particularly in connection with land acquisition, transfer, and development under the Murphy Act; also in relation to the immediate defense requirements of the United States Government in this same field. So he could not come.

This meeting of the Soil Science Society of Florida was discussed yesterday morning in the Office of the Internal Improvement Board and it was agreed that we should be represented. At that time I did not think that I could come and so the Board decided to send Mr. F. E. Bayless who is head of our Land Division. Mr. Bayless is very familiar with all aspects of the Everglades problem as he has been with us since 1920. We also requested Mr. Herman Gunter, the State Geologist, to be present and represent the Board especially in view of his extensive knowledge of the geology and ground water conditions throughout South Florida.

Upon finding at practically the last moment that I could be with you, I can tell you that I was genuinely glad for I am deeply interested in the welfare of the Everglades and of the stout-hearted and far-sighted people living out there who have had the vision and courage to develop it. To my way of thinking this is one of the outstanding areas of agricultural land, if not the outstanding area, not only in the United States but in all the world. But it does have its problems, vital, serious problems of conservation and proper use not only of its marvelously prolific soil but also of that precious lifeblood, the water which has formed these fine soils, and which must be handled in such a way that it will continue to protect and preserve them just as fully as possible.

With regard to the agricultural possibilities of the Everglades, we already know full well what can be done with vegetables; also with sugar cane. As a matter of fact, I can now tell you that only a few weeks ago I was sent by the Board of Commissioners of State Institutions to Louisiana with one of my associates to arrange for the purchase of second-hand sugar mill machinery to supplement that which we already have out at the Prison Farm near Belle Glade to enable us to make sugar of a grade satisfactory for conversion into syrup when and as needed. As most of you know, we have been making syrup out there for the past five years for the various State Institutions. We had eighty acres of fine cane which

went to waste this year because we could not get containers to put the syrup in. The Louisiana equipment has already been loaded on cars and reconstruction of the plant will be started as soon as it arrives in Belle Glade. In the meantime a certain amount of equipment also is to be purchased from the U. S. Sugar Corporation and we hope to have the plant ready to operate by next fall when we should be in a position to grind about two hundred and fifty tons of cane per day. This operation is calculated to greatly improve the quality of the syrup we shall have for the use of State Institutions in the future and also add appreciably to the efficiency of shipping and storing the product. Production will be, of course, only in such quantity as to meet the requirements of State Institutions such as the University of Florida, the Woman's College at Tallahassee, the State Prison at Raiford, and others that comprise a total of 18,000 individuals to be provided for daily.

Other possibilities for the area are very promising. Thus we are just beginning to find out what can be done with some of the starches, and with certain fiber plants such as ramie. We have a small area of about eight acres of this latter plant out at the Prison Farm near Belle Glade and it has done remarkably well. I wish I could give you an effective word picture of the fine manner in which it has grown. In one cutting from this field, we harvested around 2500 pounds of fiber ribbons which, of course, were hand-stripped by prison labor. Three or four cuttings per year are practical possibilities. There is no question at all that ramie will be one of the most important crops of the 'Glades if we ever find an efficient and effective machine for decorticating it. In fact, its splendid adaptability to that area seems to make of it a "Natural" insofar as the growth and quality of the plant is concerned. In the near future we hope to extend this planting in such a way as to provide limited amounts of planting material to anyone who may be interested in making a start with it.

I also have the feeling that the Everglades is going to be one of the outstanding feeding grounds for cattle in the Southeast. Specific developments already under way and results already obtained point very strongly to pasture development and live stock feeding as a profitable outlet for an extensive acreage. This should assist very materially, too, in the crop diversification and soil conservation problems that we have before us in this great area. There are other problems to be coped with, to be sure, including water control, insects, and nutrition but I see nothing in them over and above what we know the Agricultural Experiment Station has steadily thrived on in the past. As a matter of fact, the more we discuss the possibilities of the Everglades the more we are obliged to realize that, as yet, the real potentialities of the area have scarcely been scratched.

Now maybe we did make a mistake when we organized and installed the type of drainage system that was put in years ago. I have always thought that if we had dyked off certain areas of that land and brought it into cultivation on a unit basis, as needed, it would have been much better since the balance would then have remained under the protective influence of the natural conditions under which this soil was formed, namely, the highest possible water table throughout the year. While we have greatly upset the natural balance of the whole area by the manner in which we have gone about the project in the past, it may not be too

late to make certain amends and corrections for the future handling and development of this important section. For here we have a remarkable soil that has required thousands and thousands of years to build which is being severely damaged each year by the very nature of our reclamation operations. It becomes, therefore, not a matter of preference or choice; something *must* be done about it.

As a matter of fact, that is why I came here today; to listen to these discussions and to learn what these men scheduled to speak on this program have to say who have been studying these problems of the Everglades for many years. The statements that some of you gentlemen made to me in my office last week regarding the tremendous soil losses in the Everglades really opened my eyes. For you must remember that the State of Florida is the largest landowner down there by a considerable margin and that the responsibility for the handling and care of this land rests squarely upon the shoulders of the Trustees of the Internal Improvement Board. And so the Board has sent Mr. Bayless, Mr. Gunter, and myself down here to meet with you and to bring back any constructive suggestions that may develop in the course of this comprehensive review of the whole problem. For my own part, I sincerely hope it will be possible for you to make some definite recommendations here today; to say just what should be done.

Any way I can be of help or the Internal Improvement Board can be of help, we want to do so. I am sure that we all realize the great potential values that exist in the Everglades and what can be done out there. I am now convinced, however, that we are not taking the best advantage of this great resource that nature has placed at our disposal or are we giving it the care that is required of us if it is to continue long as an agricultural asset of the State. Frankly, we are soliciting your assistance in the solution of this important problem of soil and water conservation and from the sincerity and seriousness exhibited in the development of this program I am confident you will not fail us. I thank you.

THE PRINCIPAL CHARACTERISTICS OF THE KISSIMMEE-EVERGLADES WATERSHED

A. LAKE OKEECHOBEE

C. C. Schrontz*

It was generally recognized from inception of the reclamation plan for the Everglades that Lake Okeechobee would require regulation. This particular feature is made the subject of this paper.

Lake Okeechobee is a shallow body of fresh water, approximately circular in outline, with a surface area of 720 to 730 square miles. The surface elevation generally ranges from 14 to 18 feet Okeechobee datum, depending upon seasonal rainfall.

The tributary drainage area is of the order of 5,000 square miles. The chief tributary is the Kissimmee River which drains about two thirds of this area. Fisheating Creek and Taylor's Creek and numerous smaller streams drain the remaining area. Originally there were no defined outlet channels from the lake, but when the lake rose sufficiently high, water was spilled over the lake rim to the south into the Everglades and to the west into the Caloosahatchee valley. The rise and fall of the water surface elevation in the lake was entirely due to the relation between rainfall and inflow on one hand and evaporation absorption and seepage on the other. The storage capacity of Lake Okeechobee between surface elevations 14 and 17 feet is about 1,315,000 acre feet or about 440,000 acre feet for 1 foot depth of storage over the lake surface. It requires an outlet capacity of about 7,300 cubic feet per second flowing for one month to lower the lake surface one foot provided, of course, there is no rainfall, inflow or evaporation.

Up to about the year 1924 there were no records of continuous inflow or outflow from the lake. The only available continuous records giving any clew to the behavior of the lake were those made by the Everglades Drainage District beginning in 1915. These records, Figure 2, consisted of local rainfall, evaporation and lake surface elevations for which we should be grateful to Mr. Fred C. Elliot.

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* Associate Engineer (Civil) with U. S. Engineers, War Department, Jacksonville, Florida, since 1928. Formerly (1907-25) Mr. Schrontz was connected with various irrigation and other projects as Irrigation Engineer and Construction Engineer in Colorado and Wyoming. In October, 1925, he came to Florida and became associated with the engineering firm of the George B. Hills Company, Jacksonville. From March, 1926, to August, 1927, he was Resident Engineer of the George B. Hills Company in charge of construction of the drainage system and pumping plants of the South Florida Conservancy District, Belle Glade and Miami. During his connection with the U. S. Engineers, his duties have been concerned mostly with hydraulics in connection with navigation, flood control, power, irrigation, and drainage. He was the principal assistant to the District Engineer in the hydraulic studies in connection with the Okeechobee project. The results of hydraulic studies of the drainage spillways along the St. Lucie Canal and the control spillway of the St. Lucie Canal at the new lock were verified for performance and adequacy by elaborate model studies carried out at the U. S. Waterways Experiment Station, Vicksburg, Tennessee.

From a hydrological standpoint it is usual to break down the effect of rainfall into such elements as land and water evaporation, transpiration of vegetation, land absorption and retention or ground storage and infiltration. After these effects are fully appraised the final runoff, which is the result desired, is determined. This procedure requires a thorough and complete knowledge of all the conditions relating to each item and these are seldom available. In such cases the hydrologist is a kind of magician. His magic wand is the engineers slide rule, the "slip stick." After many contortions and incantations he is supposed to produce the conventional rabbit, but too many times the forthcoming animal has long ears, all right, but is known by another name.

From the practical standpoint, however, it is the runoff that is required to determine the means of control and it has always been a recognized fact that the sure and unfailing means of determining runoff is by long and continuous records of stream flow measurements. This is so important that the Federal Government has provided a special department in the Geological Survey to collect water resource data. In order to encourage stream flow measurements the Federal Government offers to cooperate with the State or local interests upon a fifty-fifty basis, furnish all equipment and personnel to carry on the measurements, and to publish and preserve all records for public use.

Up to the present time the State of Florida has never participated in this important service although, drainage, flood control, irrigation and municipal water supply are the most important factors in the future development of the state's resources. A number of local interests have availed themselves of this service but it has been periodical and fragmental. As soon as these local interests have what they consider sufficient information for their present needs this service will be discontinued. These short period records of stream discharge are helpful but are by no means sufficient to permanently solve the problems of reclamation and conservation. In the twelve years of my connection with the District Engineers Office, local interests have requested through their federal Senators and Representatives investigations for flood control, power, drainage and irrigation on such stream systems as the Suwannee, Withlacoochee, Hillsboro, St. Johns, Kissimmee, Peace rivers and other streams. In no case has there been sufficient stream flow data upon which to base other than a preliminary report. Our office has contributed liberally to the stream measurement service of the U. S. Geological Survey. This should not be. The failure to have participated in this service is a reflection upon the intelligence of the people of a sovereign state. You, Mr. Sovereign Citizen, have the power to correct this condition. I am impelled to exclaim "And with oceans of love why isn't something done about it." I believe I have the support of every engineer in this State on this subject.

The problem of control for Lake Okeechobee was solved by a very simple and direct expedient. The continuous record of lake surface elevations and the recorded or estimated discharge from the lake were employed. The rise and fall of the lake surface to which was added the discharge from the lake for periods of one day, a week or a month, represented the net inflow. The net inflow is used purposely to include every effect of rainfall and evaporation over the lake surface and all other gains or losses of whatever nature. A certain rise of the lake

represents water added to the lake and was considered as direct inflow. A fall of lake surface represented a loss to the lake and was considered an uncontrollable minus inflow whenever it exceeded the actual recorded or estimated discharge from the lake for the corresponding period of time. This procedure resulted in a continuous record of net inflow from the year 1915 to 1936, inclusive, covering 20 years with a complete record of inflow, a known storage capacity and a known outlet capacity through the present St. Lucie and Caloosahatchee Canals. The problem was solved by the usual mass diagram technique. The present combined capacity of the St. Lucie and Caloosahatchee Canals range from 4,150 cubic feet per second at lake surface elevation 14 feet to 9,550 cubic feet per second at surface elevation 18 feet, see Figure 3. It was found, based upon monthly inflow and discharge, that it would have been possible to control the lake between elevations 14 and 17 feet or between 15 and 18 feet. This is predicted upon a nearly perfect regulation, see Figure 4. For years such as 1928 and 1930 lake elevations slightly higher than these may be expected in October and November.

The principal difficulty in regulation is the anticipation of subsequent events of heavy rainfall and inflow. Heavy rainfall in the Kissimmee Valley and increasing inflow of the Kissimmee River gives a warning of several days. On some occasions this does not give sufficient time to provide storage capacity in the lake to care for the added inflow. A rather unique system of forecasting seasonal conditions has been provided. It consists of the accumulative relation of rainfall minus evaporation. This, for convenience, has been called the R-E function. When these functions as ordinators in inches are plotted against time the resulting curves simulate patterns representative of typical seasons. When the trend of the curves are steeply downward little or no discharge is needed; when the trend is upward discharge is required, the amount depending upon the steepness of the curve. An auxiliary rating, Table 1, gives the amount of discharge required.

In using the (R-E) function in the manner outlined in Figure 5, the forecasts are to be based upon the excess or deficiency of the accumulated precipitation for the calendar year over the accumulated evaporation for the same period in the lake area. The precipitation will be determined by the average of the U. S. Weather Bureau rainfall records at Okeechobee, Belle Glade, Ritta, and Moore Haven, and the evaporation will be the average of standard open pan evaporation records taken on the north and south shores of Lake Okeechobee. Beginning with January 1 of each year, the total accumulated rainfall for that year will be recorded weekly, and the total accumulated evaporation for that year similarly recorded, using in each case the averages of the above mentioned stations. Each week the excess or deficiency of rainfall over evaporation will be determined from the formula R-E $= \pm X$, in which R equals the accumulated rainfall to the given date, E the accumulated evaporation to that date, $+X$ the excess of rainfall over evaporation, and $-X$ the deficiency of rainfall under evaporation. If the value of X is plus, a coming rise in lake stage is indicated; if minus, a coming fall in lake stage may be expected, and the amount and rate of the change in lake stage may be predicted approximately from the amount and rate of the change in the value of X. The value of X at any time, together with the lake stage

TABLE 1.—Record of Lake Okeechobee and Discharges, Regulated by the R-E Function Method.

Month	Stage (ft.)	Gain or Loss c. f. s.	Discharge from Lake c. f. s.
		1937	
January	16.1	— 760	0
February	16.0	—1,480	0
March	15.8	+2,990	0
April	16.2	+6,060	0
May	17.0	—1,510	0
June	16.8	—5,300	0
July	16.1	—1,480	0
August	15.9	—2,230	3,350
September	15.6	0	2,070
October	15.6	+7,510	640
November	16.8	+3,840	1,370
December	17.3	—5,350	7,720
		1938	
January	16.6	—4,540	4,780
February	16.0	— 760	0
March	15.9	—2,230	0
April	15.6	—4,450	30
May	15.0	+ 740	130
June	15.1	—1,480	0
July	14.9	+2,970	0
August	15.3	— 740	0
September	15.2	+ 740	0
October	15.3	— 700	0
November	15.2	0	0
December	15.2	0	0

at that time, thus afford the most accurate available basis for indicating in advance the discharge which should be maintained from the lake in order to anticipate its changes and to regulate its elevation between safe limits. The amount of such discharge, as determined at weekly intervals by the value of X and the then existing lake stage, may be found by reference to the discharge diagram shown in Figure 6.

The following general forecasts may be made from the values of X in relation to the curves A, B, C, D, E, and F of Figure 5. Forecasts are confined to the period from June 1 to August 1. Prior to June, forecasts are not so dependable.

1. When the value of X falls above the curve A of Figure 5, there may be expected greater seasonable rainfall and a higher lake stage than the past recorded maximum. Regulation should begin immediately to the extent indicated by discharge diagram of Figure 6 for the given lake stage and value of X.

2. When X falls between curves A and B, there may be expected a rainfall and lake stage greater than the average wet year. The position of the point X will also show whether the season is likely to be slightly

or greatly in excess of the mean wet year. Corresponding regulation as indicated by the discharge diagram should be maintained.

3. When X falls between curves B and C, seasonal rainfall and a lake stage between a mean year and a mean wet year may be expected and only moderate regulation will be required, depending upon the lake stage at the time.

4. X falling between curves C and D indicates a dry year and little or no regulation will be required.

5. X falling below curve D indicates a season drier than the average dry year and normally no regulation will be required.

6. X falling below curve E indicates an excessively dry year and every means should be employed to conserve the water in the lake.

7. Hurricane years: When X equals —10 to —20 inches by the first of June, there is a definite indication of a condition favorable to subsequent hurricane occurrence. If under such condition the value of X after the first of June takes a sharp upward turn in the plotted curve the tendency toward hurricane conditions will be confirmed: should this upward trend in the value of X continue up to the first of August, hurricane occurrence may be considered imminent, and intensive regulation may then be expected.

The forecasts to be made by the curves of Figure 5 are general and comparative and give no clue to the amount of regulation discharge that should be undertaken for the different values of the (R-E) factor. The diagram of Figure 6 supplies this requirement.

A remarkable feature about this R-E function is the different type of curve shown for the hurricane years of 1926 and 1928 compared to other years. From January to June the trend of the two curves were of maximum steepness downward; from June to the middle of September they were of maximum steepness upward; then falling with gradual steepness downward to the end of the year. During the first part of the year 1938 the R-E curve followed the trend of a maximum dry year or a possible hurricane year. During the third week of May the trend of the curve changed and started upward and continued till June 1st. From that time, it continued on an irregular trend until October 15 and downward to the end of the year. The indication during June and July was unfavorable for a hurricane and at the time the forecast was to that effect. But in September a violent hurricane developed and started for the Florida coast in face of the forecast of no hurricane at Lake Okeechobee. Until it abruptly changed its course, it seemed certain that Florida and possibly Lake Okeechobee was to experience its full fury. The graph of the R-E curve is shown and the result of regulation of Lake Okeechobee during the years of 1937 and 1938 by the R-E function method indicating the lake stages and amount of discharge.

You are well informed of the improvements made in providing navigation and protection against such conditions that prevailed during the terrible hurricanes of 1926 and 1928. Our motto is build and serve.

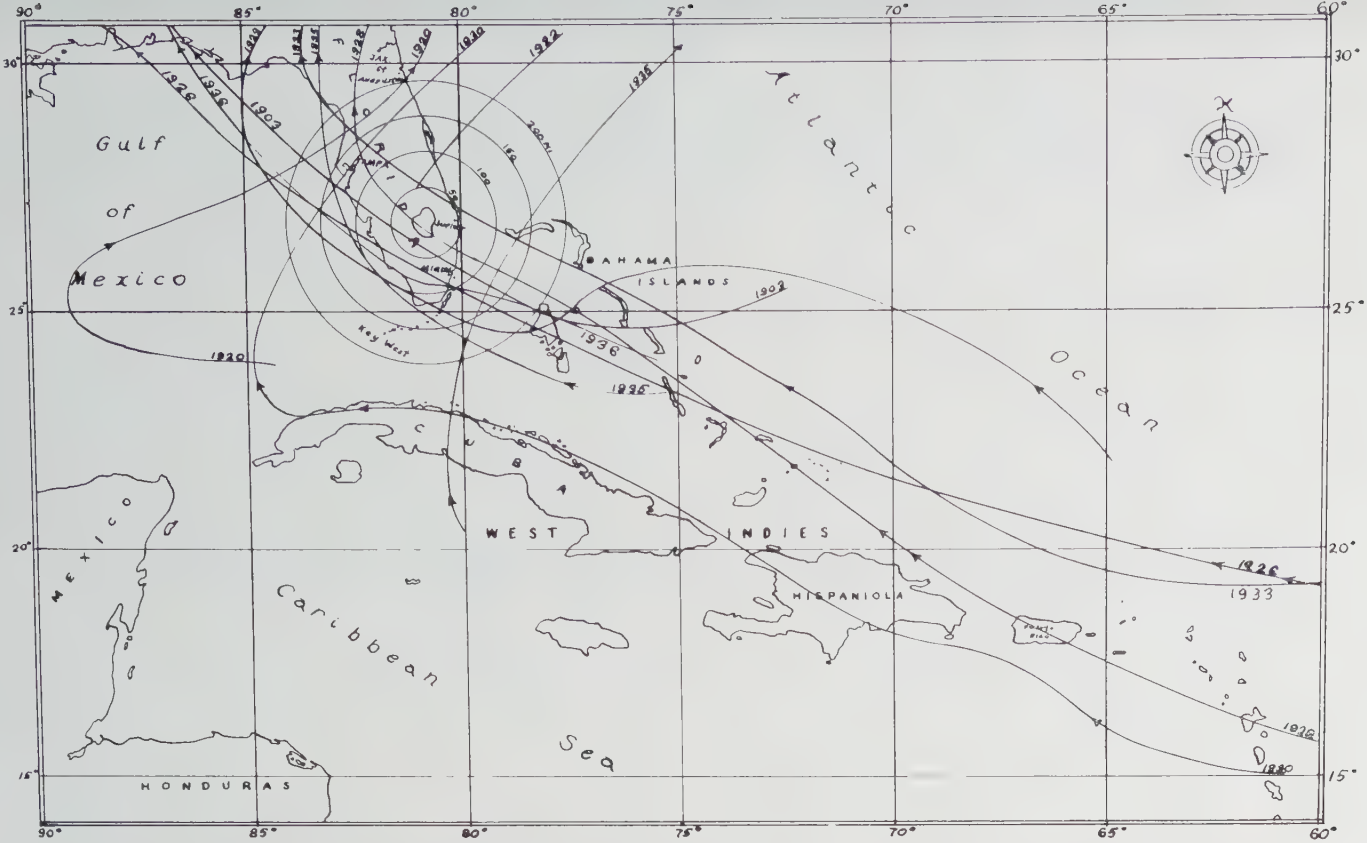

Figure 1.– Vicinity map showing the position of Lake Okeechobee (at the center of the concentric circles) in the State and in the Caribbean system in relation to the incidence and course of hurricanes, shown as dated and arrowed lines, that have affected the State since 1903.

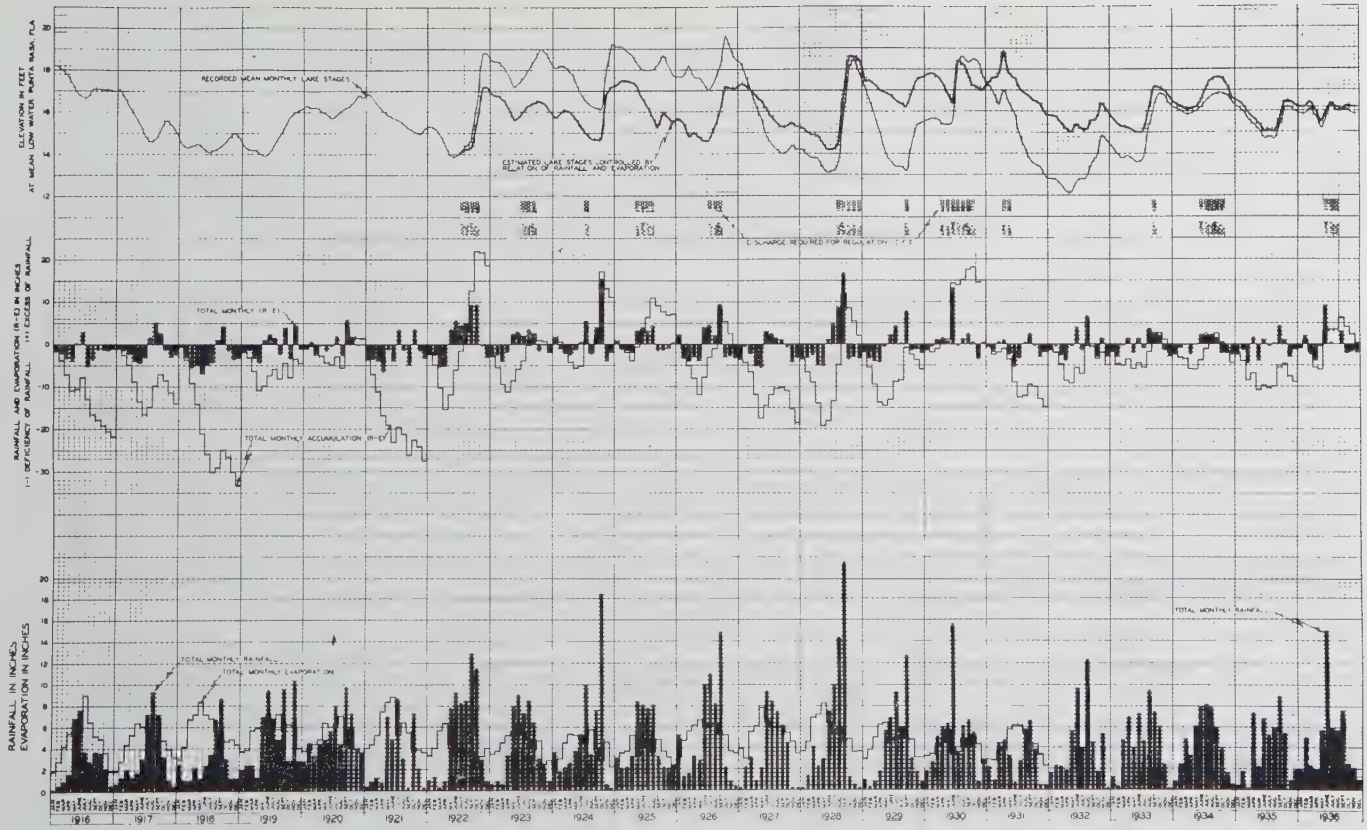

Figure 2.—Rainfall, evaporation and lake stage shown in relation to the factor (R - E) through the period 1916-1936. NOTE: Rainfall and evaporation data plotted hereon have been obtained from official records of the Everglades Drainage District made in accordance with standard Weather Bureau methods.

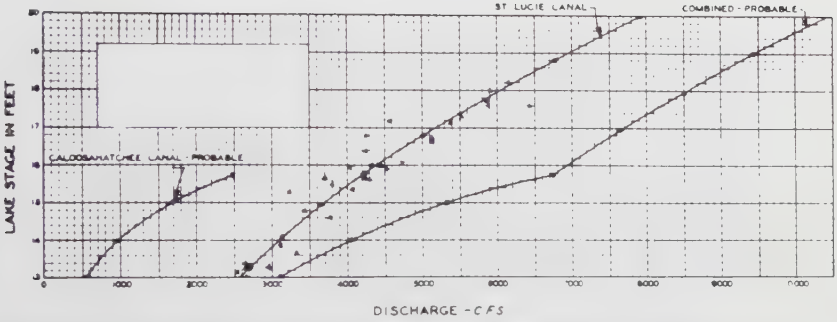

Figure 3.—Rating Curves: St. Lucie Canal based upon Lake Okeechobee stages and metered discharges, probable Caloosahatchee Canal discharge.

△ Meter measurements

○ Logarithmic mean curve

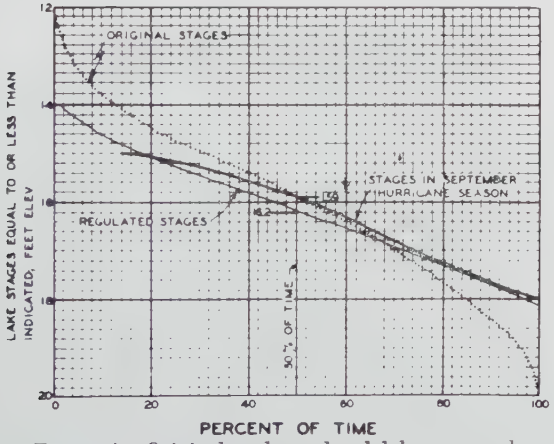

Figure 4.—Original and regulated lake stages showing per cent of time lake stages are equal to or less than indicated.

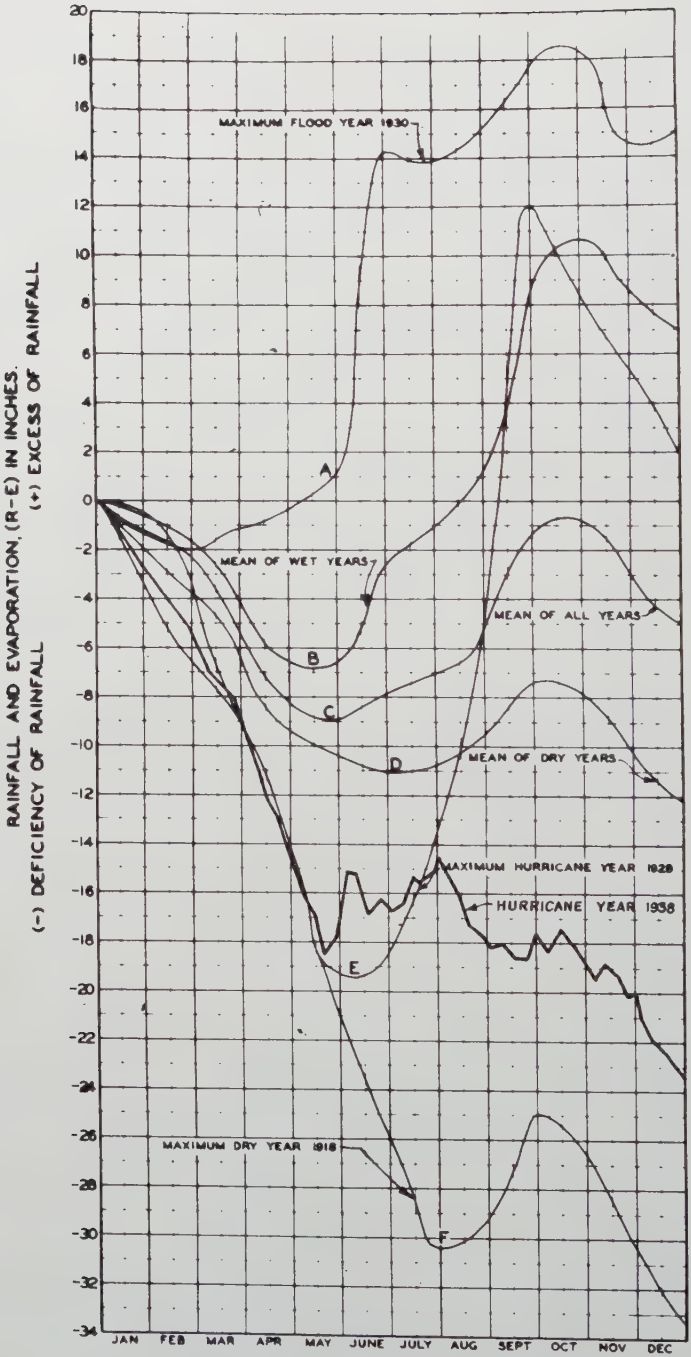

Figure 5.—Chart used in forecasting seasonal conditions affecting Lake Okeechobee stages as outlined in the text on page 17.

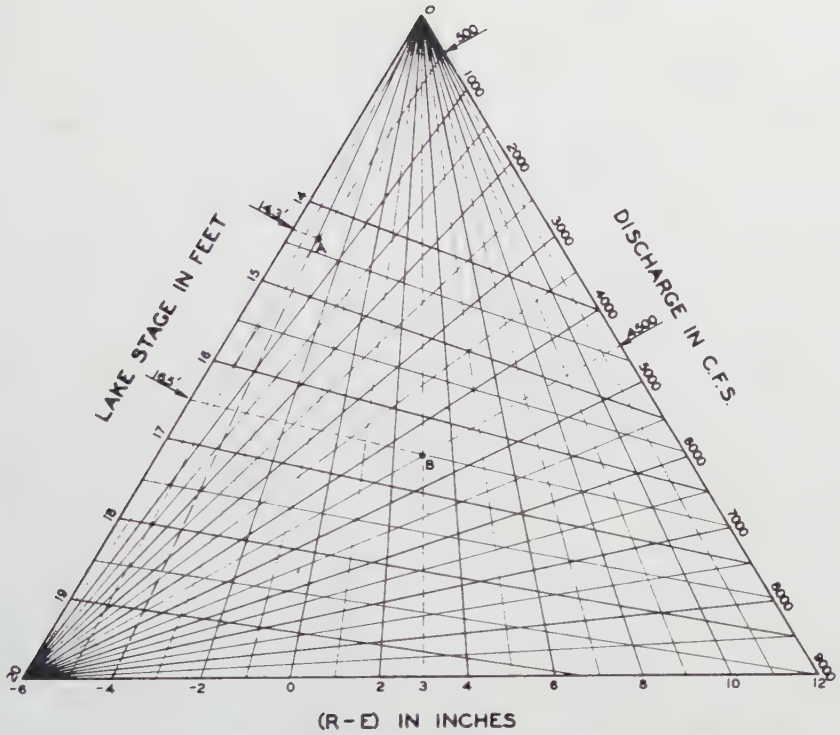

Figure 6.—Chart used in determining the total combined regulation discharge through the St. Lucie and Caloosahatchee outlet canals from Lake Okeechobee based upon a given lake stage and rainfall-evaporation factor, X = (R-E). Examples for reading diagram:

1. Required, the total regulation discharge for a lake stage 14.3 ft. and x = —4.0 inches. Spot the point A on the line corresponding —4.0 inches on the (R-E) scale, at the bottom of the diagram, and opposite 14.3 ft. on the lake stage scale as shown by dotted line. From the lower left hand vertex of the diagram project an imaginary line through point A and read on discharge scale at right edge of diagram, 500 C.F.S., the required discharge.

2. The discharge required for a lake stage of 16.5 ft. and x = 3.0 inches is 4500 C.F.S. as indicated by the dotted lines. Stages to 0.1 ft. and values of x to 0.1 inch are to be interpolated and corresponding discharge taken to the nearest 100 C.F.S. by scale.

Rules for regulation to be used in connection with Figure 6:

1. In general the regulation period shall be confined to the four months, June to September. Should the lake stages continue to rise materially above 17 feet after September, regulation should be continued until the stage remains stationary between 17 and 18 feet after which time outlet gates should be closed and water conserved in anticipation of generally falling stages during winter and spring months.

2. No regulation will be required when the lake stage is below 14.0 ft. or when the rainfall-evaporation factor x, (R-E) is numerically greater than —6.0 inches.

3. When the lake stage is above 14.0 feet and x = 12 inches or more all outlet canals should be opened to full capacity.

4. When x = —6.0 to 12.0 inches obtained from the last previous weekly records of rainfall-evaporation, the diagram (Figure 6) will indicate the proper discharge to be maintained for the coming week.

5. During seasons in which hurricanes may be expected as shown by forecasts from Figure 5 and when the lake is higher than 16 feet, increase the discharge to be maintained for the coming week to twice that indicated by Figure 6 and maintain same until the lake stage has been lowered to 15.5 feet or until hurricane hazard has passed.

THE PRINCIPAL CHARACTERISTICS OF THE KISSIMMEE-EVERGLADES WATERSHED

B. THE EVERGLADES

J. C. Stephens*

This paper attempts to describe briefly the present topographic and hydrologic conditions in the Everglades. The effects of artificial drainage and the inefficiency of the present canal system, as shown by recent surveys and observations, will be given.

Evidence will be presented to show that haphazard development has contributed to this condition, and data will be offered indicating that planned development will in some measure alleviate it.

The third, or downstream, drainage unit of the Kissimmee-Everglades watershed is the Everglades proper, covering an area of approximately 4,000 square miles. The principal topographic feature of this area is that of a shallow slough 35 to 50 miles wide bounded on the east by a coastal fringe of sand dunes and on the west by the Ocaloacoochee Slough and Big Cypress Swamp. Surveys show that within the Everglades there is a wide, flat plain flanked on both sides by natural drainage ways, separating the area into two distinct topographic types with entirely different physical and hydrological characteristics. The broad, flat area, termed the "saw grass plain," is fairly dry during the winter and spring months, while the drainage areas termed "ridge-and-slough sections" are usually wet the year around.

Surveys show that artificial drainage has exerted a profound influence on the original topography of the saw grass plains. In the northern part of the area, around the Bolles Canal, subsidence and fires have reversed the original slope of the land so that water tends to flow northward toward Lake Okeechobee. As a matter of fact, this is generally true for all of the drained and cultivated land bordering the Lake. Topographic surveys show that subsidence valleys have been formed along the canals, the depth and width being determined by the amount of drainage afforded.

The mean annual rainfall over the Everglades ranges from approximately 60 inches at Miami to 50 inches at Lake Okeechobee. In general, it is slightly higher near the coast, decreasing toward the interior. The variation from year to year is large and the yearly distribution is uneven, resulting in the regular wet and dry season.

Evaporation and transpiration losses in the Everglades are very high. Results of experiments conducted on test plots at the Everglades Experiment Station by Mr. B. S. Clayton, Associate Engineer, show that the average annual rainfall exceeds evaporation losses from open water by only six inches, while annual water losses from normal sawgrass actually

* Project Engineer for the Everglades Project of the U. S. Soil Conservation Service since January, 1940, with headquarters in Fort Lauderdale. Formerly (1934-40) Assistant Project Engineer and Acting Hydrologist, Soil Conservation Service, Dadeville, Alabama.

amounts to thirteen inches more than the rainfall. These plot results, applied to the Everglades, furnish an apparent paradox, indicating that there is not enough water supplied by rainfall to satisfy the enormous thirst of the dense vegetation. Inasmuch as there is known to be runoff from the area, it appears, on first thought, that an additional supply must come into the Everglades, presumably from underground flow. Although the test plot results may be entirely correct, there is always a question as to their application to larger areas. In this case, we have a relatively small area as a model and an enormous area—the Everglades—as the prototype. Quite frankly, the laws of similitude between model and prototype, in this instance, are unknown at present.

In order to further examine the application of these laws to the Everglades, additional tests and experiments are planned. First, since evaporation varies with humidity, tanks will be installed in the undeveloped glades where air humidity may be different from that near the Everglades Experiment Station. Second, areas a square mile or more in extent will be diked off and studied as rainfall retention areas. Third, observation wells will be drilled to proper depths into the underlying rock in order to determine the probability of underground flow.

Runoff from the Everglades is via two routes, surface and underground. Briefly, the Everglades appears to be divided into two main categories in regard to underground flow: the interior portion where rock structure is relatively tight and water moves underground with difficulty, and the outer portion nearer the coast where water moves freely through the supporting rock. Underground flow probably contributes only a small proportion of water losses, yet its relation to water control is far more important than has been considered in the past. For example, control of the water table by diking and pumping is believed to be feasible over the more impermeable rocks; whereas, over the more permeable areas this method has proved impractical unless there was a blanket of muck or marl of sufficient thickness overlying the formation to provide a relatively impervious layer.

The close relationship of underground and surface hydraulics and the importance of both to water control is illustrated by the graphs of Figure 1. This shows the rate of inflow per mile along the North New River Canal under flood conditions and under semi-drought conditions.

In interpreting the results of this study it should be borne in mind that, in general, the upper section of this canal, from the Bolles Canal to 26-Mile Bend, was open and surface water drained into it with little obstruction. However, from 26-Mile Bend to Lock No. 2, the surface flow into the canal was obstructed by dikes. As indicated by the graph, the rock from the Bolles Canal to 20-Mile Bend is relatively tight while from 20-Mile Bend to Lock No. 2 it is of a more open texture, allowing underground water to move through it much more freely.

The restraining influence of dikes in checking flood runoff should be noted. It also should be seen that the seepage rate through the porous rock is more than double that through the tighter formations. Incidentally, there is recent evidence that the seepage rate near the end of the Miami Canal is many times greater than it is along the North New River.

Surface runoff from the Everglades is principally from existing drainage canals and amounts to 10 to 15 percent of the rainfall in normal years,

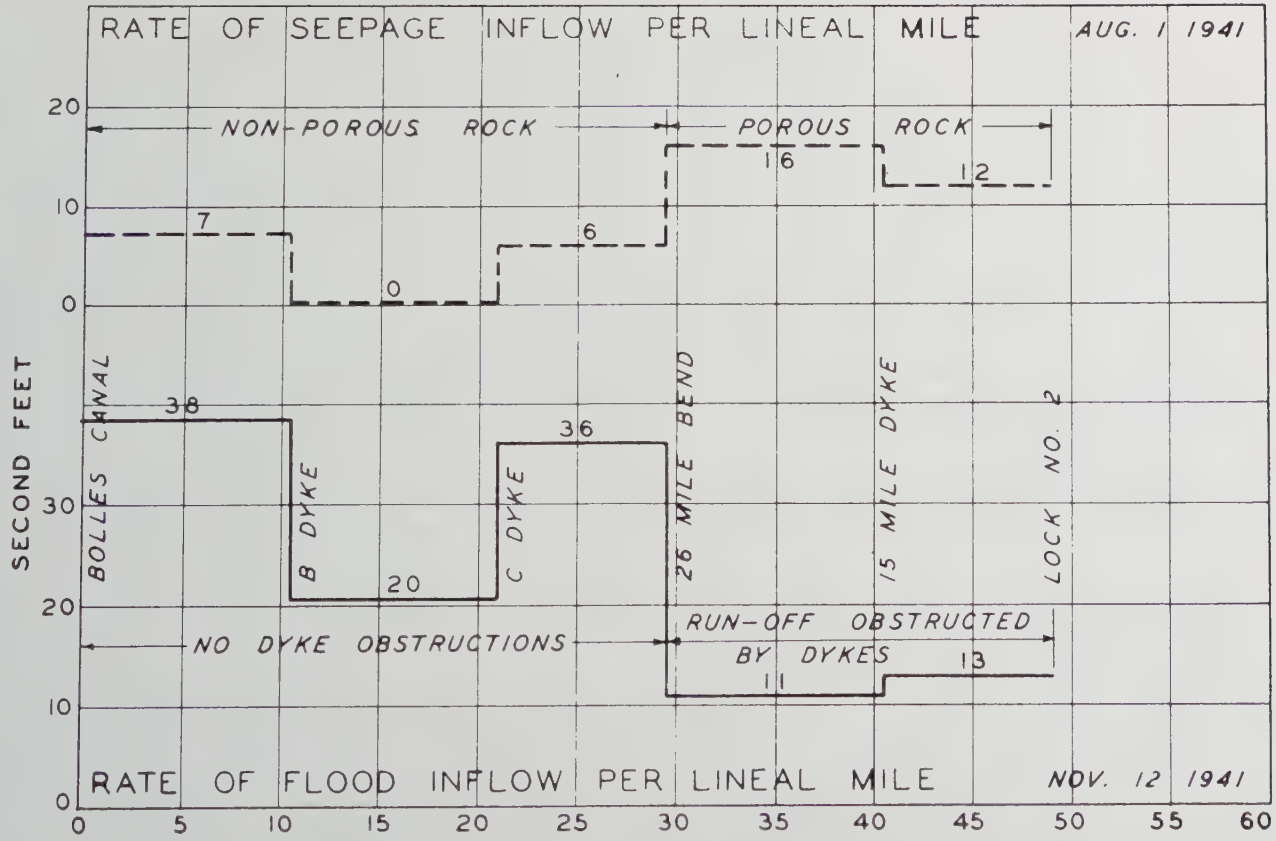

Figure 1.—Rate of inflow into the North New River Canal.

Unfortunately, under present conditions, these canals overdrain the land in dry seasons, while they are inadequate to furnish flood relief during the wet season. Their inadequacy for flood relief was shown by simultaneous flow measurements made by the United States Army Engineers along all of them.

It has been found that the inflow from the undeveloped sections of the Everglades overtaxed the capacity of the canals and reversed the flow along their upper reaches. Likewise, this same water contributed by the raw lands, created a flood hazard in the cultivated lands along their lower reaches. Thus, the more valuable lands on both ends of such drainage lines had to wait until the water drained off of the uncultivated and undeveloped lands in the open Glades before they could obtain relief. Quite often this has been too late.

The possibility of aiding in flood control, and also of holding higher water tables during droughts to assist in controlling fires and subsidence by diking off unused sections of the open glades, is shown graphically in Figure 1. A flood-routing diagram worked up by the standard method employed by the U. S. Army Engineers for such a proposed storage area located north and east of the Hillsboro Canal, with a gross surface expanse of approximately 400 square miles and an estimated storage capacity of 231,400 acre-feet, indicates the feasibility of such projects from an engineering standpoint. A spillway length of 130 feet was calculated to be sufficient for this area to keep the water level from rising over a maximum of two feet for two successive years of heavy rainfall, such as occurred in 1928. For normal years, the maximum pool stages may be expected to fluctuate under one and one-half feet.

In order to use such a system, drainage by gravity flow in peat soils must be abandoned and agriculture confined to definite authorized areas having adequate water control. Experience has shown such a procedure to be desirable. For instance, when a farmer along the middle portion of a canal, insists that the canal level be held at a particular stage for his convenience, in order for him to obtain gravity drainage, it is impossible to maintain satisfactory stages for others along the upper and lower reaches of the canal. This has already resulted in numerous arguments between farming interests in the north and south portions of the district and resulted in what is known, locally, as "shotgun farming."

It has been found, furthermore, that to protect organic soil from fire and subsidence, canal levels should be maintained as close to ground surface as possible. Maintenance of water tables near ground surface cannot be attained without more flexible control than is permitted by gravity flow.

If the development of areas where diking and pumping are impractical is increased, developers will demand a sea level canal which may lead to the contamination of ground water supplies with salty water. This contamination has already been experienced in one area during periods of drought in a manner that will be discussed in more detail in another paper.

The above discussion may be summarized briefly as follows: a canal will carry only a definite amount of water; during storms, canals are overtaxed while during dry spells they are too low to maintain proper

water tables. Storage basins are needed to regulate canal flow and utilize the canals more efficiently. Pumps and dikes are necessary to care for storm periods and assist in carrying water into storage basins. Agricultural development should be restricted to controllable units and indiscriminate drainage of reservoir areas discouraged.

THE HISTORY OF EVERGLADES DRAINAGE AND ITS PRESENT STATUS

W. Turner Wallis*

The original assignment to Fred C. Elliot of "The History of Everglades Drainage and Its Present Status" was especially fitting, as he has the most intimate knowledge of this subject of any person I know, and I express for him his keen disappointment in being unexpectedly prevented from attending a meeting of as great significance as this for the future progress and development of the Everglades.

Serving as his substitute on rather short notice I must ask your indulgence for the extent to which I have quoted from existing published records, particularly Senate Document No. 89, 63d. Congress, 1st Session, entitled "Everglades of Florida—acts, reports and other papers, state and national, relating to the Everglades of Florida and their reclamation."

As early as the year 1845, the attention of the Government of the United States was officially called to the Everglades of Florida. In that year the Legislature of Florida, by a joint resolution instructed the Senators and Representatives from Florida to press upon the National Congress the importance of examining and surveying the Everglades, with a view to their reclamation.

In 1847 Hon. J. D. Westcott, Jr., United States Senator from Florida, requested the Secretary of the Treasury to appoint an agent to make a reconnaissance and report as to the probable practicability of the work of reclamation, to be laid before Congress at its next session.

On June 18, 1847, Mr. Buckinham Smith, of St. Augustine, was appointed to procure authentic information in relation to what are generally called the "EVER GLADES" on the peninsula of Florida, for the purpose of ascertaining the practicability and expediency of draining them.

On June 1, 1848, Mr. Smith transmitted to the Secretary of the Treasury his report, which was submitted to the Senate on August 10, 1848.

By Act of Congress of September 28, 1850, known as the "Swamp and Overflow Land Grant Act," authority was conferred on the Secretary of the Interior to convey to the several states all swamp and overflow lands, as defined by said Act, such conveyances to be by patent upon the request of the governor, vesting the fee simple title to said lands in the state subject to the disposal of the legislature thereof: "Provided, however, that the proceeds of said lands, whether from sale or by direct appropriation in kind, shall be applied, exclusively, as far as necessary, to the purpose of reclaiming said lands by means of the levies and drains aforesaid."

* Engineer; Public Debt and Tax Analyst; Consultant to the Florida State Planning Board and National Resources Planning Board; and active member of the Soil and Water Conservation Committee of the Soil Science Society of Florida since the founding of the Society in 1939. Formerly Engineer for Everglades Drainage District and actively engaged in Everglades reclamation and development for past twenty-two years, serving as Engineer, Fiscal and Administrative agent to sub-drainage districts and private interests, and specializing in tax and debt readjustment programs.

More than 20,000,000 acres of land, including those embraced within the Everglades, were received by Florida under the provisions of this Act.

The present Trustees of the Internal Improvement Fund of the State of Florida were created by an act, approved January 6, 1855, which irrevocably vested in said Trustees the lands granted to the State of Florida under the Swamp and Overflow Land Grant Act, for the purposes and trusts therein set forth.

Until 1879, when Governor Drew vetoed the first attempted railroad land-grant of swamp and overflow lands by the legislature, the Trustees adhered strictly to the terms of the grant by Congress, and in each instance during this period when the legislature sought to divert either the fund, or the lands belonging thereto, to other purposes, such attempted legislation was vetoed.

Beginning in 1879, all legislative acts to grant swamp and overflow lands to railroad companies contained provisions making the grants subject to the trusts and provisions of the act approved January 6, 1855. Of the fifteen million acres granted between 1879 and 1900 to encourage the construction of railroads, the Trustees conveyed title to upward of eight million acres of swamp and overflow lands, in accordance with a policy of regarding such acts as absolute grants of the lands therein described.

To regain management of the Fund by the Trustees, temporarily placed in the hands of the United States Court, because of matured obligations for which there were no available funds, four million acres of swamp and overflow lands, were sold to Hamilton Disston during the first term of Governor Bloxam, beginning in 1881. The proceeds of this sale were applied to return the entire fund to the control and management of the Trustees.

On February 26, 1881, the Trustees contracted with Disston and others (Atlantic and Gulf Coast Canal and Okeechobee Land Company) to drain and reclaim at their own expense and charge all the overflow lands in the State of Florida lying south of Township 23 and east of Peace Creek belonging to the State of Florida or the Trustees of the Internal Improvement Fund.

The original Disston contract established a drainage area or district embracing approximately nine million acres of land, with the company to receive for its expenditure in drainage operations deeds from the Trustees to alternate sections of State lands, reclaimed and made fit for cultivation.

Under this agreement drainage operations began near Kissimmee and were prosecuted for some years, during which time many questions were raised about the drainage operation, resulting in an act of the legislature authorizing the governor to appoint a committee to investigate the quantity of land reclaimed for the state and other matters.

As a result of the extensive investigation and report of this committee, comprised of Messrs. J. J. Daniel, W. H. Davison and John Bradford, the Disston contract was amended August 17, 1888, to give the company one acre of land for each twenty-five cents expended on the reclamation program. The change in the contract permitted drainage operations to be carried on in the Kissimmee Valley, and the only canals dug in the Everglades area were one connecting Caloosahatchee River with Lake Okee-

chobee (Three Mile) and one extending south from Lake Okeechobee into the Glades without outlet. Work under the Disston contract ceased about 1889.

By 1900, statutory grants to railroads, canal transportation companies, and other disposition of the swamp and overflow lands of the fund had already absorbed not only nearly all of the lands in the Everglades, but nearly all similar lands in the State. Legislative land grants were so numerous and so conflicting that frequently tracts or grants overlapped, or lands were called for which did not even exist. During the early part of 1901, representatives of various railroad companies made demand for hearings before the Trustees to settle questions of priorities between claimants under railroad land-grant acts.

As the result of a sale by the Trustees to Neill G. Wade of approximately 100,000 acres of land, proceeds to be used for drainage work, the railroad companies brought suit to recover the lands or the proceeds arising from the sale, and challenged the power of the Trustees to sell the lands and use the proceeds for any other purpose than to turn the money over to the railroad claimants.

These conditions led to an investigation of the whole subject matter and history of the Internal Improvement Fund, resulting in the adoption by the Trustees of a resolution asserting a superior title to the lands in the fund over that of the railroad claimants under subsequent and residuary legislative enactments, and declaring it to be the fixed determination and policy of the Trustees to defend the title to the lands for the purpose of performing the trust of drainage and reclamation.

Upon announcement of this decision and the refusal of the Trustees to execute deeds under or by virtue of any railroad land-grant act, numerous suits were instituted, and active litigation to compel the issuance of such deeds was started by the railroad companies in 1902.

During the Jennings administration, ending January 1, 1905, no deeds were executed by the Trustees, either voluntarily or under compulsion by the courts.

In a test case, tacitly agreed upon by all the railroad companies, and so presented, application was made before Judge Swayne to enjoin the Trustees from the exercise of any discretionary power over the fund or any disposition of any of the lands for any purpose other than to deed them to railroad companies under their respective land grants made by the legislature.

With the Trustees claiming the power to do all of the things complained of and full discretion to sell and dispose of the lands, and to use the proceeds for purposes of drainage and reclamation, the whole fund, its management and disposition, were involved and dependent upon the outcome of this suit.

A decision expressly upholding the contention of the Trustees and the policy adopted in 1901 was rendered by Judge Swayne on May 2, 1907.

In the latter part of 1902, Governor Jennings had much data compiled relating to the feasibility and practicability of draining the Everglades, the topography, rainfall, watershed, and elevations above sea level, showing the normal level of Lake Okeechobee to be 20.42 feet above the level of the Gulf of Mexico. In his message to the legislature of 1903 major reference was made to the nature and character of the soil, its fertility

and growths thereon, naming the principal drainage outlets to be deepened by the cutting of canals from Lake Okeechobee to both the Gulf and Atlantic Ocean.

In March, 1903, application was made to the Federal government for patent to the State of Florida for the lands comprising the Everglades, and on April 29, 1903, the patent was issued.

The actual start of what might be termed the present drainage program was hastened by the contention raised in the suit of the Louisville & Nashville Railroad Company, to the effect that the Trustees were not performing any of the trusts required of them under the law. As soon as Governor Jennings' term as Governor had expired, he was appointed general counsel of the Trustees and recommended to Governor Broward an immediate start of dredging work in the Miami River, because of the serious threat to the Trustees' legal position from this contention and proof that during his administration no funds had been spent for drainage.

The drainage tax law, enacted by the 1905 legislature to provide additional funds to insure the drainage and reclamation of the Everglades, was declared unconstitutional by the United States Court. The basis of this unfavorable decision was the delegation of authority by the Legislature to the Board of Drainage Commissioners to, first, establish drainage districts and to fix the boundaries thereoef, and, second, to levy an acreage tax not exceeding 10 cents per acre per annum to be fixed annually by the Board.

An amended drainage law, adopted by the 1907 legislature, describing the boundaries of the district, and levying a tax of 5 cents per acre annually, including the year 1907, was sustained by the United States circuit court of appeals, and the litigation was then amicably settled between the litigants, resulting in the appointment of J. O. Wright, chief drainage engineer, and the Furst Clark Construction Company's contract for the drainage of the Everglades.

In the suits seeking to enjoin the collection of a drainage tax and to have the law declared unconstitutional, the most difficult problem and matter from the State's standpoint was the charge that there was insufficient technical information touching the feasibility and practicability of the drainage of the Everglades to sustain a special assessment and the expenditure of public money.

To meet this charge, request was made to the United States Department of Agriculture for assistance, and the Secretary ordered an investigation by the office of Experiment Stations, to obtain the most reliable and competent information that could be procured. The report was prepared by J. C. Wright, supervising drainage engineer.

The right of the State School Fund, under the State Constitution, to 25 per cent of the proceeds of the sales of all public lands, including swamp and overflow, was determined in February 1908, and an accounting made on all prior sales by the Trustees.

Other acomplishments during the administration of Governor Broward towards the reclamation of the Everglades, included the construction of four dredges and several important sales of Everglades lands, particularly the one to R. J. Bollos, providing a million-dollar fund for the work.

Major accomplishments during the four-year period, 1909 to 1912, included, first, an agreement with the large land owners to dismiss all

suits pending in the Supreme Court of the United States to enjoin the collection of the 5 cent acreage tax, and to pay all drainage taxes thereafter; second, an increase from four to eight in the number of dredges at work; and, third, widespread sales of lands increasing the demand for a more rapid rate of progress with the reclamation program.

In response to this demand the 1913 Legislature enacted the law creating Everglades Drainage District, levying a graduated system of acreage taxes in accordance with benefits, with authority for the District to issue bonds supported by the proceeds of the acreage tax levies.

The investigation of the Florida Everglades Engineering Commission (Isham Randolph report) was completed in October, 1913, and the recommendations of this report have served as the basis of all subsequent drainage work.

During the following eighteen-year period from 1913 to 1931, Everglades Drainage District was able, from the proceeds of bonds, direct application of taxes and advances from the Trustees to excavate 440 miles of canal, 47 miles of protective levee around Lake Okeechobee, and to complete 16 locks, at a total cost of eighteen million dollars.

The financial stability of the District during this period was in large measure due to the policy of the Trustees of purchasing all tax certificates sold for the non-payment of taxes by private owners, resulting in a 100 per cent collection of all taxes levied.

The depletion of Trustee funds derived from land sales, and many related factors including the collapse of the Florida "boom," the hurricanes of 1926 and 1928, and national economic conditions caused a default on January 1, 1931, on the scheduled payments against the outstanding bonded indebtedness. The period from 1931 to date has been one of endless litigation, accompanied by a complete cessation of all construction and with very little maintenance work by the District.

Chapter 20658, Laws of Florida, Acts of 1941, is that under which Everglades Drainage District now operates. The purpose of the acreage tax, as set forth in this Act, is to enable the Board "to pay the principal of and interest on all obligations of Everglades Drainage District heretofore incurred and now outstanding, and any refunding bonds hereafter issued." Except for the one-half mill ad valorem tax, provided to pay "the cost of administering the affairs of the said District generally," there are no funds available for either maintenance or the construction of new reclamation facilities.

With the indebtedness of the District reduced in amount to approximately $5,300,000 by the Plan of Refunding made possible by the loan obtained from Reconstruction Finance Corporation, and the annual burden of acreage taxes reduced from $2,000,000 to $600,000, there is an acute and growing need for the determination of the future reclamation policy for the Everglades. The longer this is delayed the more difficult it will be to undertake the conservation and development of the resources of this area.

THE SOILS OF THE EVERGLADES IN RELATION TO RECLAMATION AND CONSERVATION OPERATIONS

CHARLES B. EVANS* and R. V. ALLISON†

It has been known for many years that the organic soils of the Everglades, just like soils of this general type elsewhere, are very susceptible to oxidation and shrinkage losses under conditions of excessive drainage or cultivation. As a matter of fact this is probably the most important point to be made in this brief review of the distribution and physical characteristics of the more important soils of this area and their potential agricultural value.

While we all know of the very great capacity of our Everglades soils to grow plants and produce remarkable yields, it is feared we have given much too little thought to the rate at which they are disappearing right before our eyes, especially as a result of the highly promiscuous program of drainage and cultivation to which they have been subjected. As a matter of fact there are records which show that in other parts of the country and in other countries of the world, deposits of organic soils just as deep as ours here in the Everglades have entirely disappeared under the influence of agricultural development. In this connection we must keep in mind, too, that most of our Everglades soils are underlain by lime rock!

These and related problems of a regional nature pertaining to water conservation and a whole circle of benefits prospectively associated with a comprehensive plan of development for the Everglades area were discussed in a preliminary way at the foundation meeting of the Soil Science Society of Florida in Hollywood, in April, 1939, and reported in its First Proceedings (pp. 35-57). However, in the development of a problem of such broad public interest, we shall very briefly restate some of the more important of these conservation aspects at this time even at the risk of a certain amount of repetition.

CONSERVATION UNDER RECLAIMED AND UNRECLAIMED CONDITIONS

In any careful consideration of soil conservation in the Everglades it obviously is necessary, first of all, to give separate consideration to the requirements of cultivated and uncultivated areas. For the former, the only practical solution of the problem is rewatering and maintaining the water table just as high as possible throughout the year. As already

* Associate Soil Scientist, Soil Conservation Service, in charge Everglades Survey since 1939. A member of the Mobile Survey Staff of the Service since 1934, Mr. Evans acted as Party Chief on the Susquehanna Watershed survey in New York and Pennsylvania and the Lloyd Shoals Reservoir Watershed in Georgia as well as various other surveys in the eastern part of the United States.

† Head, Soils Department, College of Agriculture, University of Florida, Gainesville, since 1937. Formerly Soil Chemist and Biologist, Tropical Plant Research Foundation, Washington, D. C., and Baragna, Cuba (1924-26); Soils Specialist, Everglades Experiment Station, 1926-33; Chief of Division, Soil and Water Conservation Investigations, U. S. Department of Agriculture, Bureau of Chemistry and Soils (1933-35) and Soil Conservation Service (1935-37).

suggested, a balanced and well-planned program for the entire Everglades from this standpoint will not only prove the answer to soil conservation but to many related problems as well, including domestic water supplies, water for irrigation, magnificent natural conditions for wild life refuges and, to a certain extent at least, the amelioration of winter temperatures.

There are few people in South Florida, not already informed in the matter, who will believe that winter temperatures have been recorded as low as 9° F. in the open glades under conditions of a low water table. However, we scarcely need mention the great public concern that already has developed in South Florida regarding the future of domestic water supplies especially in certain metropolitan areas. Neither should we take the time to discuss in any detail the need for stabilizing and conserving our natural water supply before undertaking to consider seriously the development of extensive parks or the encouragement of wild life refuges in the back country since most of us know from first hand observation and experience what has happened out there in the past.

The incorporation of the idea of rewatering as a conservation measure in a general plan of development for the Everglades should include, of course, the unit basis of reclamation. Of this approach you are certain to hear a great deal during the present conference and through the months to come.

The most difficult aspect of the whole problem of soil conservation in the Everglades is, without doubt, that which develops under cultivated conditions where the water table must be held at a reasonable depth to permit field operations. In other words we still have a long way to go in developing systems of land use and applying them to these organic soils which will tend to stabilize their mass and reduce their annual subsidence to a very low rate, if not halt it entirely. Agricultural permanence absolutely requires that it be entirely stopped at some point while there still remains a sufficient depth of soil for economic and effective use.

The combustible character of our Everglades soils, when exposed either to fire or natural oxidation is, of course, associated with their highly organic character since the organic components of these peat and muck types are made up almost entirely of plant remains. Thus fibrous, sawgrass peat has only 10 to 12 per cent ash while this value in the more mineralized mucks in the vicinity of Lake Okeechobee, locally referred to as "Custard Apple Soils," may run as high as 50 to 60 per cent or higher. This relationship is made quite clear in Table 1, where certain profile characteristics and the mineral content of various horizons or layers of three of the most important Everglades types are shown; also in Figures 1-5 which illustrate how freely these soils shrink and burn when exposed to excessive drainage and cultivation.

TABLE 1.—Some Physical and Chemical Characteristics of Three Important Everglades Soil Types.

Soil Type		Depth	Character of Organic Material	Ash Content (%)[4]	CaO Plus MgO (%)[5]	N (%)[5]	P_2O_5 (%)[5]	K_2O (%)[5]	pH	Volume Weight (Lbs. per Cu. Ft.)[6]
OKEECHOBEE MUCK[1]	1	0″- 9″	Black, granular to moist, plastic muck	64.35	2.342	1.51	0.22	0.249	5.80	[7]
	2	9″-13″	Similar to No. 1, containing some fibrous peat	50.31	2.885	1.85	0.15	0.294	5.46	--
	3	13″-26″	Dense, black, plastic muck	63.07	2.713	1.63	0.10	0.384	5.83	19.17
	4	26″-33″	Brown, fibrous, sawgrass peat	8.76	3.264	3.44	0.08	0.100	5.83	9.38
	5	33″-58″	Sawgrass peat with black, slightly plastic matrix	17.03	5.477	2.84	0.08	0.100	6.22	12.83
	6	58″-72″	Generally similar to but more fibrous than No. 5	9.11	4.816	2.95	0.05	0.114	6.39	—[8]
	7	72″-77″	Yellow, very fibrous, sawgrass peat	8.46	4.448	3.18	0.04	0.143	6.64	--
	8	77″-94″	Sawgrass peat with black, slightly plastic matrix	19.05	5.331	2.82	0.05	0.106	6.98	--
	9	94″-104″	Black, plastic muck mixed with fibrous peat and sand; some marl pockets at interface with rock	81.27	1.917	0.79	0.05	0.220	7.83	—
OKEELANTA PEATY MUCK[2]	1	0″- 6″	Brown, fibrous peat, fairly well decomposed	38.38	3.322	2.22	0.24	0.234	5.97	16.52
	2	6″-14″	Very dense, yellow, fibrous sawgrass peat	8.34	4.360	3.46	0.10	0.096	6.05	8.13
	3	14″-19″	Black, plastic muck with considerable fiber	44.71	2.803	2.31	0.13	0.052	5.97	16.12
	4	19″-23″	Brown, fibrous sawgrass peat	28.31	3.998	2.86	0.11	0.234	5.97	11.89
	5	23″-36″	Black, plastic muck	64.59	3.155	1.32	0.07	0.360	6.14	20.13
	6	36″-66″	Dark brown, fibrous, sawgrass peat	10.79	5.233	2.67	0.04	0.124	5.88	8.82
	7	66″-69″	Yellow, very fibrous sawgrass peat	7.42	3.998	3.03	0.04	0.081	6.25	—[8]
	8	69″-77″	Dark brown fibrous sawgrass peat	12.48	5.151	3.18	0.05	0.172	6.81	—
	9	77″-82″	Yellow, very fibrous peat with some black, plastic matrix at interface with rock	13.32	4.435	3.41	0.04	0.100	6.93	—
EVERGLADES PEAT[3]	1	0″- 5″	Brown, fibrous sawgrass peat	12.01	5.529	3.84	0.22	0.135	6.47	7.32
	2	5″-15″	Yellowish-brown, coarsely fibrous, sawgrass peat	7.10	5.907	3.15	0.09	0.108	6.39	6.42
	3	15″-29″	Dark brown finely fibrous sawgrass peat	7.77	6.332	3.04	0.06	0.094	6.47	6.84
	4	29″-34″	Dark brown, sawgrass peat with slightly plastic matrix	9.44	7.006	3.07	0.06	0.120	6.39	8.05
	5	34″-51″	Brown, coarsely fibrous, sawgrass peat	7.52	5.821	2.73	0.08	0.116	6.56	5.55
	6	51″-58″	Yellowish-brown, coarsely fibrous, sawgrass peat	6.44	4.973	2.97	0.10	0.124	6.81	—[8]
	7	58″-66″	Brown, coarsely fibrous, sawgrass peat	9.43	4.057	3.53	0.04	0.114	6.98	—
	8	66″-70″	Coarsely fibrous, matted, sawgrass peat with some sand; marl pockets at interface with rock	32.09	5.963	2.85	0.07	0.153	7.49	—

[1] Profile taken from N.W. ¼ Section 14, West of South Bay, April, 1929.

[2] Profile taken from center of south line of Section 5, South of Belle Glade, April, 1929.

[3] Profile taken from position 300 feet West of North New River Canal and 15 miles South of South Bay, May, 1929.

[4] Calculated as loss on ignition, oven dry basis.

[5] Calculated on oven dry basis.

[6] Calculated basis field volume of soil, oven dried.

[7] Too dry for accurate sampling.

[8] At or below water table.

Figure 1.—Drying and cracking of Okeechobee peaty muck ("Willow and Elder Land") in the Canal Point area.

The Everglades Drainage District has within its boundaries approximately seven thousand square miles and occupies most of the southeastern part of the state of Florida. However, only about half of this area is involved in what might be regarded as the Everglades proper. This report, furthermore, is concerned primarily with that portion of the Everglades lying south of the West Palm Beach Canal and Lake Okeechobee, north and east of the Miami Canal, and west of the West Dixie Highway.

In view of the detailed description of this general area from the topographical and geological standpoint that has been and will be given by other members on this program, these features will not be reviewed in any detail in this particular phase of the whole discussion. Perhaps it will suffice to say that the extreme flatness and great extent of the area and the variable porosity of the supporting geologic formations in different sections must be treated as prime factors in developing the fine degree of water control that is made especially necessary by the requirements of its organic soils.

East of the main body of organic soils is a coastal area of slightly higher land composed largely of gently rolling sandy plains or low ridges. Drainage through these ridges was originally accomplished by natural streams such as the North New River and the Miami River which transect the ridge. However, the original drainage pattern and topography of the Everglades has been greatly altered by artificial drainage and consequent subsidence of the land. For instance, broad but shallow subsidence valleys have been formed along the canals. The depth and width of the valleys are determined largely by the degree of drainage afforded by a particular canal. Along the North New River Canal, for instance, the valley effect that has developed extends practically its entire length, and is approximately three miles wide sloping gradually toward the canal with the area of greatest subsidence in the immediate vicinity of the channel. In the northern part of the Everglades, around the Bolles Canal, subsidence and fires have actually reversed the original slope of the land. Much significance is to be

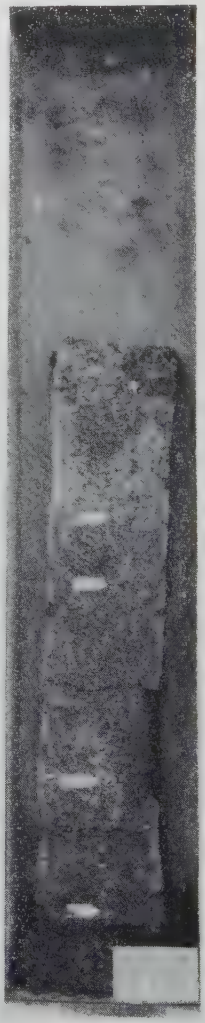

Figure 2.—Shrinkage of an Everglades peat profile upon air-drying. The size of the original block of soil cut from the surface to a depth of four feet with the use of the container in which it is pictured was 6″x9″x48″. The profile is standing surface end down on account of the looseness of the topsoil. Shrinkage of this soil under such conditions is commonly found to be three or four volumes into one. The profile was taken from a central glades location 15 miles south of South Bay and about 300 feet west of the North New River Canal.

attached to this subsidence of the land surface not only from the fact that the depth to rock is progressively decreased and the productive life of the soil diminished to that extent but also on account of the change it brings about in the whole maintenance program from the water control standpoint.

A very great advantage we now have in reviewing this important problem of soil conservation in the Everglades which has not been available in the past is an excellent reconnaissance soils map of the area which is now nearing completion (Figure 6). The preparation of this map was made possible during the past three years by the Everglades project that has been organized by the Soil Conservation Service of the U. S. Depart-

Figure 3.—Extensive fire in the Open Glades looking eastward from the bridge at Geerworth (near Six-Mile Bend) towards West Palm Beach along Highway No. 25.

Figure 4.—A ten to twelve foot dike built of peat burned completely to a depth of a foot or more beneath the natural ground surface. Reconstruction must be preceded by removal of ash from the dike site to effect satisfactory bondage for the prevention of excessive seepage.

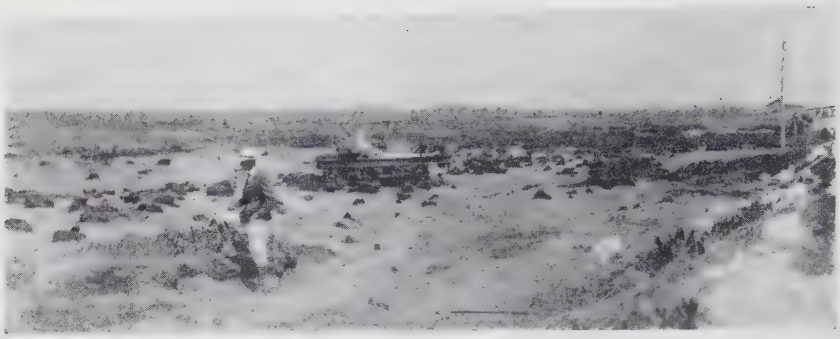

Figure 5.—Badly burned area of Okeelanta peaty muck west of Highway 26, south of South Bay, near Okeelanta. The excavated profiles (6″x9″x48″), inset, were taken from and near the unburned island in the left foreground of the picture, that on the left being from the unburned section and that on the right from the burned area immediately adjacent. Note the loose, fibrous character of the topsoil, especially in the unburned profile, and the shiny, plastic layer of sedimentary muck about two-thirds of the way down these profiles that is characteristic of this type. The ash in the two-quart can represents the remains of considerably more than a foot of this valuable soil lost for all time as the result of a single fire.

ment of Agriculture under the leadership of Mr. C. Kay Davis as Project Manager. Like many other phases of the work of this project, this soil survey was greatly facilitated by an air survey that gave excellent photograhpic material to work with over an aggregate area of about 7500 square miles. Fortunately the air survey was one of the first phases of the project to be undertaken by the Service.

In other words, as a result of this survey, we shall know for the first time *what* the Everglades soils are, *where* they are, and *how much* of each type we have. Naturally, such information is an indispensable background for any comprehensive, worth while land use planning, whether for the area as a whole or for any part or section of it. However, in order to make the best and most practical use of this map, in terms of its very great value as a basis for future planning, we shall have to be very sympathetic with and even tolerant of the story it tells us. Florida, in general,

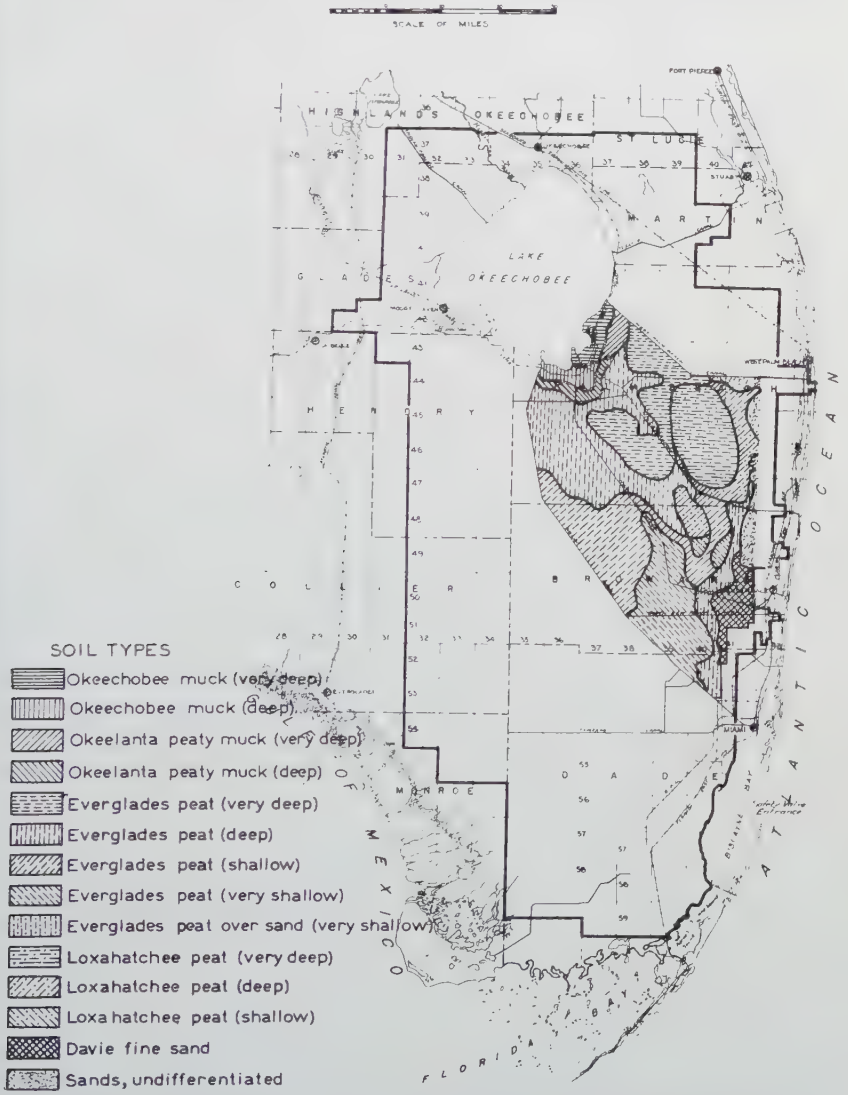

Figure 6.—Reconnaissance soil map of that section of the Everglades included between the Miami and West Palm Beach canals. Preliminary draft.

and the Everglades in particular, have too many real agricultural opportunities to permit us to do other than look our problems, whatever they are or wherever we find them, squarely in the face as they come along. It is by this attitude that we shall make the most rapid and permanent progress.

THE SOIL SURVEY

The soil survey of the Everglades region was begun in January, 1940. Transportation, as is usually the case in conducting any investigation in this area, rather promptly proved a major problem. After much trial and error, however, it was found that caterpillar tractors, preferably those powered by 35 to 50 H.P. engines and equipped with five-foot extension cleats, were the best means of transportation over the sawgrass plains which occupy the north central part of this great tract. Air-boats, which are flat-bottomed skiffs propelled by Ford V-8 engines mounted on an A-frame and turning airplane propellors, proved to be adequate for negotiating the wet ridge and slough country which flanks the sawgrass plains both to the east and west and probably represents the main drainage area of the glades. Glades buggies, equipped with tractor wheels in some cases and rubber tires in others, were used successfully on the prairies and rock lands adjacent to the organic soils especially to the north, west, and south.

With these three types of equipment, it was found possible to finish surveying that portion of the glades lying east of the Miami Canal, south of Lake Okeechobee and west of the Range Road last year, as shown in Figure 6. Excellent progress has been made to date on the remainder of the organic soils and the completion of the entire area by the end of the present fiscal year is a definite possibility.

In the open sawgrass plains, east and west lines were run every six miles and supplemented by north and south lines wherever additional information seemed necessary to complete the survey in adequate detail. Soundings were first taken along these lines every 330 feet but later every other station was omitted. Aerial photographs were used for a base map, and since the sawgrass plains had very few outstanding features by which locations could be determined, the information was plotted according to chained distances. However, the soundings appear on the photographs only at one-half mile intervals, the 660-foot spacing having proved excessive except as additional information for notes.

Soundings in the ridge and slough country were taken more or less at random by traversing the sloughs with an air-boat and maintaining locations by the physical characteristics appearing on the aerial photographs. Soundings and samples were taken at one to two mile intervals, usually near an outstanding physical feature, such as an island, a large alligator hole, a well-defined pond, or a section or township corner. Photographs on a scale of one and one-half inches to the mile were used in the ridge and slough areas and on the sawgrass plains.

Near the eastern edge of the glades where sand and mineral soils begin to intrude into the organic area, soundings and samples were taken much more frequently. A like amount of detail was necessary in the vicinity of Lake Okeechobee because of the intimate association of valuable agricultural lands in this section. Most of the land in these areas is in culti-

vation, and in order to show all the physical features such as dikes, ditches, pumping plants, etc., as well as the present land use, large scale pictures were necessary. This work was done on a scale of four inches to the mile.

Four major types of organic soils have been found in the Everglades area to date, namely Okeechobee muck, Okeelanta peaty muck, Everglades peat, and Loxahatchee peat. Several minor types were also separated, but are relatively unimportant for the purposes of this discussion. Where these organic soils are underlain by rock, the depth to the limestone has considerable bearing on the value of the soil. Experience with water control operations in the Everglades has indicated that a depth of more than five feet of peat over rock is essential to justify the reclamation of raw lands since a few years of subsidence will soon make it necessary to lower the ditches into the rock. With this fact in view, but keeping in mind the possibility that technical improvements in pumping plants and drainage techniques, or changing economic conditions might alter the situation, the following depth separations were decided upon: very shallow phase, less than three feet of peat; shallow phase, three to five feet of peat; deep phase, five to eight feet of peat; very deep phase, more than eight feet of peat. In some locations the peat is underlain by two or more feet of sand or marl. Where this is the case, the depth of the peat is not such a limiting factor as where it is underlain by rock, since it will be possible to cultivate the sand or marl even after the organic cover has been completely oxidized. Consequently, the types underlain by appreciable depths of sand or marl are regarded as soils having permanent agricultural value.

Okeechobee Muck, the most valuable organic soil mapped, occurs in the vicinity of Lake Okeechobee as a bordering zone along its southern and eastern shores, extending outward therefrom for a distance of 1 to 3 or 3½ miles. This is a heavy, black organic material having a relatively high mineral content that ranges from 30 to 60 per cent or more (See Table 1). When wet, it becomes very plastic and sticky. Upon drying it becomes quite hard and compact and cracks badly though the surface soil of cultivated fields usually breaks down into a deep, dusty, pulverulent mulch. This heavy muck is fairly uniform and is generally underlain at from 30 to 60 inches by brown fibrous peat which in most cases rests directly on rock at depths greater than five feet. Sometimes one or more alternations of peat and muck layers occur in the profile. The very deep phase of this muck, that is, over eight feet, borders the eastern rim of the lake. The deep phase occurs along the southern shore.

Locally known as "Custard Apple Muck," this soil is very desirable, both for the production of sugar cane and truck crops. Being relatively high, it becomes very dry in winter and irrigation is necessary, especially for truck crops. Most of the 25,000 acres mapped to date are under intensive cultivation.

Okeelanta Peaty Muck, locally known as "Willow and Elder land," borders the Okeechobee muck. It has from six to eighteen inches of finely fibrous, partially decomposed organic matter overlaying a stratum of muck generally similar in physical characteristics and mineral content to the Okeechobee muck. This varies in thickness from two to thirty or more inches. Occasionally a six to twelve-inch layer of raw, brown, fibrous

peat will be found between the black, oxidized surface layer of peat and the heavy muck horizon. When the layer of heavy material occurs appreciably below the two-foot depth, its effect on soil productivity is lessened, at least for the time being, and the soil is no longer classed as Okeelanta peaty muck.

This soil type actually represents the transition stage between the Okeechobee muck and the Everglades peat, and is highly desirable both from the standpoint of location and quality. A total of about 30,000 acres of the deep phase and very deep phase has been mapped to date (Figure 6). A large percentage of this land is in cultivation at the present time and the development of the remainder, in all probability, will follow in the near future.

Everglades Peat, which occupies the broad, flat sawgrass plains, is the most extensive soil type in the Everglades. The top six to eighteen inches usually is a black, finely fibrous organic material containing from 8 to 15 per cent mineral matter (Table 1). This is underlain by brown fibrous material resting at varying depths on either rock or sand. This type is suitable for cultivation with the addition of light treatments of certain trace elements such as copper, manganese, and zinc, usually in the sulfate forms; and comparatively heavy applications of phosphate and potash, provided the depth to underlying limestone is sufficient. As previously stated, where deep sand is the substratum, the depth of the organic material is not the limiting factor. Everglades peat, deep phase, and Everglades peat, very deep phase, are the only two phases underlain by limestone that have sufficient depth to warrant intensive development and cultivation.

More than 125,000 acres of the Everglades peat, very deep phase, and more than 225,000 acres of the deep phase have been mapped so far (Figure 6). These two phases, aggregating more than 350,000 acres, form a tremendous area of cultivable soil in the upper glades, very little of which is under development at the present time.

The Everglades peat, shallow phase, differs in profile from the deeper peats mainly in its depth to rock. A total of 168,000 acres of the shallow phase has been mapped to date, mostly south of the Broward-Palm Beach County line. At best, this phase is of doubtful agricultural value and should not be considered as cultivable.

The very shallow phase is, of course, even less desirable for cultivation than the shallow phase, since it averages less than three feet in depth and, in places, the underlying rock appears at the surface. Approximately 127,000 acres of this phase have been mapped and will probably find their best use as a wildlife refuge or reservoir area for the storage of water reserves. As an added complication, large portions of both the shallow phase and the very shallow phase of the Everglades peat occur over the very porous limestone known as Miami Oolite, a fact that makes water control particularly difficult, especially on restricted areas.

Loxahatchee Peat is a very soft, felty, brown fibrous material, spongy in character, that has been formed, for the most part, from more succulent plants than the sawgrass that has given rise to the Everglades peats. Occasionally, lenses of black, finely fibrous material occur within the profile but, for the most part, this soil is a mass or raw, brown fiber from the surface down. Loxahatchee peat is usually found in more inaccessible

sections of the Everglades. A total of 165,000 acres have been mapped to date, mostly north of the Hillsboro canal and west of the Lake Worth Drainage District dikes. Most of this area is covered with water the greater part of the year and some of the larger sloughs and alligator holes have water standing from three to four feet deep most of the year. Fish and frogs are plentiful in these holes and sloughs, and ducks in large numbers winter in the area. Many Seminole Indians obtain part of their livelihood from the Loxahatchee areas, and hundreds of sportsmen find the duck shooting excellent. Some attempts have been made to bring small areas of Loxahatchee peat into cultivation, but these have proven unsuccessful for the most part.

Loxahatchee peat, being light and fluffy, does not lend itself readily to diking, since it loses more than three-fourths of its volume upon drying. It is apparent that the land represented by this type should not be considered for agricultural purposes until all others in the glades are exhausted. A few thousand acres of the shallow phase were mapped, but they are of minor importance.

Along the eastern margin of the district three separations were made totaling over 130,000 acres that are of permanent agricultural value. These are Everglades peat over sand, Davie fine sand, and the Arzell complex (Figure 6). Everglades peat over sand is a finely fibrous organic material varying from one to approximately three feet in thickness, underlain by two or more feet of sand. The value of this particular type depends largely on the fact that the sand can be cultivated after the peat layer has been lost, provided, of course, that a water table can be maintained that is consistent with the demands of the growing crops. The Davie fine sand was originally covered with from one to three feet of peat. However, this peat has shrunk or has been oxidized or burned until only a shallow covering, if any, is left. This has been or will be incorporated into the top six to ten inches of the underlying sand. This top six to ten inches of dark gray surface soil is underlain by brownish gray to white sands resting on the underlying rock. The Davie fine sand is an excellent agricultural soil. Large areas of citrus are growing on this soil in the vicinity of Davie. It is also used extensively for truck crops and as pasture land. The Arzell complex is a mixture of Arzell, Plummer, Broward, and Portsmouth fine sands. These soils are located in a slightly higher position than the Everglades and originally supported a growth of cypress trees. They are used extensively for truck farming and will remain of permanent agricultural value provided the water table can be maintained at desirable levels.

A summation of the organic soils surveyed to date, shows that there are approximately 400,000 acres in the vicinity of Lake Okeechobee having a depth of five feet or more and which may be classed as suitable for cultivation. Of this 400,000 acres, approximately 55,000 acres are being cultivated at the present time. This leaves 345,000 acres of good peat that has been provided with a certain amount of drainage. Consequently it is being subjected to excessive oxidation without furnishing any economic returns to the State or Nation. At the present rate of loss, these 345,000 acres will not long remain in their present classification.

In order to determine the approximate amount of loss that can be expected in these soils, a detailed survey was made along the North New River canal from Twenty-Six Mile Bend to South Bay that duplicated an

earlier study made by the Bureau of Soils in 1915. While these data have not been completely tabulated, from preliminary comparisons it is found that from two feet, in the shallow areas near Twenty-six Mile Bend, to five feet in the deeper areas near the Bolles canal, have been lost either through fires or natural oxidation and shrinkage. These figures are borne out by elevation losses on subsidence lines run by the Everglades Experiment Station in the same vicinity and on other areas around the lake. There is no good reason to expect that approximately the same losses will not be experienced in the next twenty-five years unless there is a decided improvement in the manner in which these lands are handled. Consequently, if we are going to prolong the life of these soils, the water table must be closely controlled and improved conservation measures practiced under cultivated conditions. Furthermore, if we are to preserve the raw, undeveloped lands of the open glades for future use, then possibly our hydrological objective for the whole area should be changed from that of rapid and complete removal of water to its retention in certain areas for conservation purposes.

SUMMARY AND CONCLUSIONS

Surveys and investigations made to date show that past pratices and present policies in effect in the Everglades have resulted in wasteful and inefficient use of its natural resources, both soil and water. They also show that much less than 50% of the organic soils of the area are suitable for cultivation or capable of supporting a tax structure of any kind. Furthermore, the area of potentially arable lands is getting smaller each year through deliberate soil wastage largely as a result of improper water control.

The present conditions of water control allow drainage from raw lands to impair the efficiency of drainage operations in the more valuable areas or in those now under cultivation. Attempted development of lands incapable of supporting agriculture will accentuate this condition.

Unplanned and uncontrolled drainage conditions are also resulting in the serious contamination of municipal water supplies.

It is very doubtful if an effective water control program can be developed for the Everglades area until a land use plan has been developed, and adopted that is based squarely upon the physical character and capability of the land from every standpoint.

It is recommended that a unit plan of development be adopted with principal reliance placed upon pumping units rather than gravity drainage in order to provide greater flexibility in water control.

Lands incapable of supporting taxation should be completely relieved and placed in public ownership to be used as permanent reservoir areas, parks, and/or wildlife reserves. Equitable adjustment should be made with present owners.

Surveys and studies should be continued to obtain more complete information on ways and means for efficient soil conservation and water control under reclaimed as well as unreclaimed conditions.

NOTES ON THE GEOLOGY AND GROUND WATER OF THE EVERGLADES IN SOUTHERN FLORIDA

GARALD G. PARKER*

INTRODUCTION

These notes on the geology and ground water of the Everglades area, southern Florida, are the result of studies incomplete at the time of the present writing, being made as part of the comprehensive investigation of water resources in southeastern Florida by the Geological Survey, U. S. Department of the Interior, in cooperation with Dade County and the cities of Miami, Miami Beach, and Coral Gables. The ground water investigations are under the direction of O. E. Meinzer, Geologist-in-Charge of the Ground Water Division of the Survey, and under the general supervision of V. T. Stringfield, Geologist, in the same Division. The writer is indebted to many members of the Federal Survey and cooperating officials who have helped him in this work. Thanks are due W. P. Cross, Associate Engineer, formerly in charge of the Miami office; also C. Wythe Cooke, Senior Geologist, S. K. Love, Associate Chemist, and Herbert A. Swenson, Junior Chemist, all of the Federal Geological Survey. Acknowledgements are also due Herman Gunter, Geologist, and Sidney A. Stubbs, Assistant Geologist, of the Florida Geological Survey; and C. Kay Davis, Project Manager, and John C. Stephens, Assistant Engineer, Everglades Project of the U. S. Department of Agriculture, Soil Conservation Service. Many city and county officials, and well drillers of the area also have aided effectively. Especial credit is due my co-workers Nevin D. Hoy, Laboratory and Field Assistant; Russell H. Brown, Assistant Engineer, whose field crew installed a line of shallow wells through the heart of the Everglades; and Ross A. Ellwood, Draftsman, who prepared the illustrations.

When the present ground water survey was begun in the fall of 1939 it was found that, although several thousand wells existed in Dade County alone, little information was available on the water-bearing formations in the area and very few cuttings from wells had been taken. In view of this it was necessary, therefore, in the spring of 1940, to engage in a program of test well drilling to obtain information on the water-bearing formations with special reference to the occurrence of water and to the quantity and quality of water available.

To date 42 test wells have been drilled either for the Federal Geological Survey or under its direct supervision. Samples from over 100 other wells in the area that have been collected through the cooperation of well drillers and others are now being studied. Of the 42 Federal Geological Survey wells, 14 range from 200 to 350 feet in depth, one is 604 feet deep, one 812 feet, and the others range between 35 and 120 feet.

These wells are located, as shown on the map, Figure 2, in Dade and Broward Counties. Most of them are in the southern and eastern parts of

* Assistant Geologist, Geological Survey, U. S. Department of the Interior, in charge of geological field studies and research in the Southeastern Florida Water Resources Investigations since 1939.

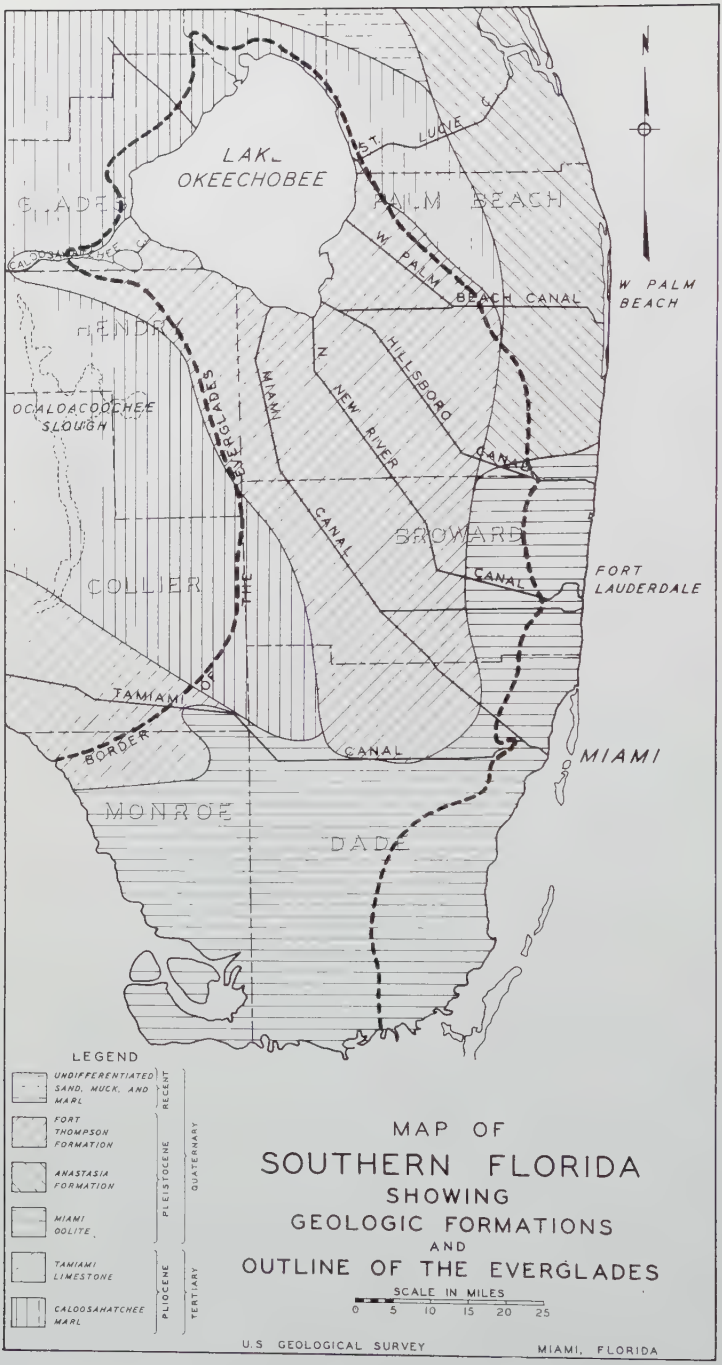
LAKE OKEECHOBEE
ST. LUCIE
GLADES
PALM BEACH
W PALM BEACH CANAL
W PALM BEACH
HENDRY
HILLSBORO CANAL
NEW RIVER CANAL
MIAMI CANAL
OCALOACOOCHEE SLOUGH
EVERGLADES
BROWARD
FORT LAUDERDALE
COLLIER
TAMIAMI TRAIL
BORDER OF THE EVERGLADES
MIAMI
MONROE
DADE
LEGEND
UNDIFFERENTIATED SAND, MUCK, AND MARL
RECENT
FORT THOMPSON FORMATION
ANASTASIA FORMATION
MIAMI OOLITE
PLEISTOCENE
QUATERNARY
TAMIAMI LIMESTONE
CALOOSAHATCHEE MARL
PLIOCENE
TERTIARY
MAP OF
SOUTHERN FLORIDA
SHOWING
GEOLOGIC FORMATIONS
AND
OUTLINE OF THE EVERGLADES
SCALE IN MILES
0 5 10 15 20 25
U.S GEOLOGICAL SURVEY
MIAMI, FLORIDA

Figure 1.

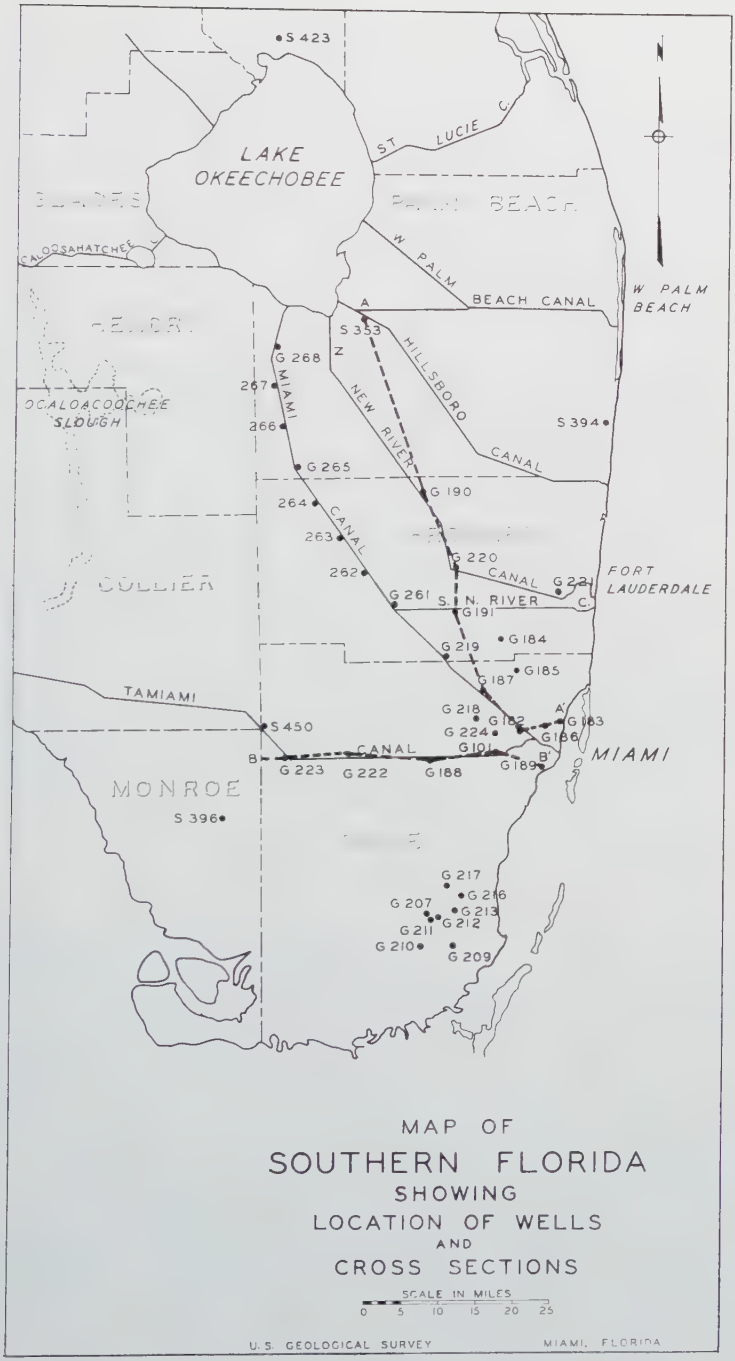
S 423
LAKE OKEECHOBEE
ST LUCIE C.
W PALM BEACH CANAL
W PALM BEACH
OSCEOLA
OKEECHOBEE
PALM BEACH
OCALOACOOCHEE SLOUGH
S 353
G 268
267
266
MIAMI CANAL
NEW RIVER
HILLSBORO CANAL
S 394
G 265
264
263
262
G 190
G 220
CANAL
G 221
FORT LAUDERDALE
G 261
S. N. RIVER
C-11
G 191
G 184
G 219
G 185
G 187
TAMIAMI
G 218
G 182
G 183
S 450
G 224
G 186
CANAL
G 101
MIAMI
G 223
G 222
G 188
G 189
MONROE
S 396
G 217
G 216
G 207
G 213
G 212
G 211
G 210
G 209
MAP OF
SOUTHERN FLORIDA
SHOWING
LOCATION OF WELLS
AND
CROSS SECTIONS
SCALE IN MILES
0 5 10 15 20 25
U.S. GEOLOGICAL SURVEY
MIAMI, FLORIDA

Figure 2.

the Everglades and along the coastal ridge. Nine wells 1¼-inches in diameter and 30-45 feet deep were hand drilled in the heart of the Everglades along the Miami Canal (Table 3). Water samples and a few samples of the rock penetrated were collected from these wells, but the inaccessibility of the area prevented the use of heavy drilling equipment needed in order to obtain adequate samples of rock for making stratigraphic studies.

A report by Stringfield, of the Federal Geological Survey on the ground water and geology of the area around Lake Okeechobee in 1933[1] indicates some of the ground-water problems that might be expected in the Everglades. That investigation was chiefly a reconnaissance and did not include the drilling of test wells. The report, however, thoroughly covers the area immediately surrounding Lake Okeechobee, thus supplementing the work of the present survey.

Early in 1942, the U. S. Department of Agriculture, Soil Conservation Service, indicated that specific information concerning the geology and ground waters in certain parts of the Everglades was needed in evaluating land-use capabilities, and in the designing and placement of structures such as dikes and dams for controlling the water table, muck fires, and soil subsidence. Accordingly, arrangements were made for the Federal Geological Survey to cooperate with the Soil Conservation Service in a program designed to furnish the desired data. Sites have been chosen in critical areas for fifteen test wells, and drilling will commence early in June 1942. Some of these are out of the reach of ordinary means of transportation and will have to be reached by the use of "'glades buggies," air-boats, and other special vehicles which will transport men and equipment to the sites. For this purpose special equipment, designed for ease of handling as well as for efficiency in drilling, is being planned. This program, when completed, doubtless will give much needed information on the geology and hydrology in remote areas of the Everglades.

THE EVERGLADES

The Everglades, a region of organic soils, occupies an irregularly defined area of over 4,000 square miles, lying between two slightly higher areas, the Big Cypress Swamp on the west and the coastal ridge on the east. These form the so-called "rim of the Everglades" and enclose the vast saw grass marsh on two sides. On the north, arms of the Everglades extend along the west and northwest sides of Lake Okeechobee, but on the east side of the lake the Everglades extend only about half way up; there they merge into the Allapattah Marsh and cypress swamps. South and southwest the Everglades extend from the lake in a vast sweep about 40 miles wide and 100 miles long, fading out near the Bay of Florida and the Gulf of Mexico into salt-water marshes and mangrove swamps. The actual line between Everglades and cypress swamp or prairie is often very difficult to determine, but the true boundary is found where the sedges of the Everglades give way to true grasses and cypress, or to salt-marsh plants and mangroves (Figure 1).

[1] Stringfield, V. T., Ground water in the Lake Okeechobee Area, Fla., Fla. State Board of Conservation, Geological Dept., Rept. of Investigations No. 2, 1933.

Great portions of the northern and eastern parts of the Everglades are almost treeless, with saw grass (*Mariscus jamaicensis*), a sedge, growing to heights of 10 or 12 feet (See Figures 3 and 4). Low shrubs and trees of myrtle, willow, and bay appear on slightly raised areas, generally in isolated clumps called "hammocks." Along the spoil banks of the canals, however, where the elevation is a few feet higher than the land surface nearby, these and many other trees and shrubs grow in rank profusion. In the westernmost and easternmost parts of the Everglades there are many of these hammocks, elongated in accordance with the general drainage of the area, and swinging from a north-south or northwest-southeast alinement in the northern part to a northeast-southwest alinement in the southwest portion.

Figure 3.—Looking northeast across the Everglades with the weed-filled Miami Canal in the foreground. Beside the big tree is the camp of the crew drilling test well G-262. Note the extreme flatness of the Everglades, and the north-south trending hammocks faintly visible in the distance.

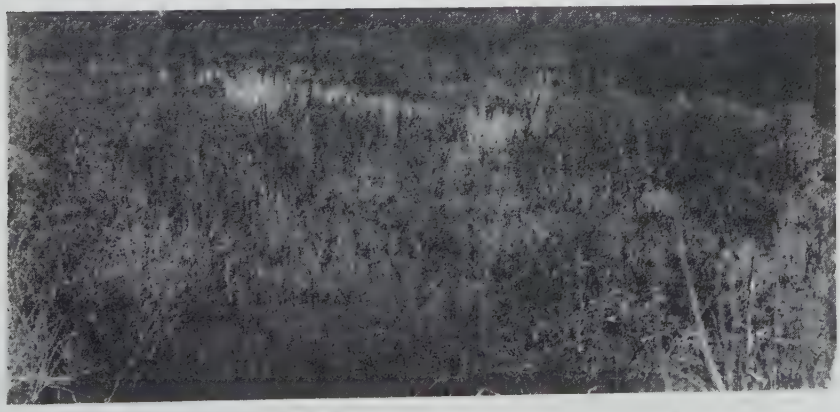

Figure 4.—The saw grass *(Mariscus jamaicensis)*, a sedge, is one of the chief impediments to travel in the Everglades. The soft muck and varying depths of water add to the difficulty. Scene of this picture is from the site of G-184, 12 miles west of Hollywood.

ORIGIN OF THE EVERGLADES

The Everglades are the result of slow vegetative decay in an area having low elevation, warm climate, and heavy rainfall, and would continue to build up on a surface having even a steeper gradient than that now existing there were it not for the drainage systems man has installed. Surface-water flow and vegetative accumulation are opposed, but the gradient would have to be greatly increased before running water would begin to cut down the gradually thickening mass of plant remains that makes up the organic soils of the Everglades. This accumulation has a thickness of about 8 feet or more in the vicinity of Lake Okeechobee with rather uniform distribution. Gradually it thins out in all directions toward the sides of the Everglades.

Several writers have described the Everglades as a vast sink or basin, but no sink or basinlike structure is necessary for the formation of a swamp like the Everglades; they are of the type exemplified by the Dismal Swamp of North Carolina and Virginia, which continues to build up on a much steeper gradient than that existent in the Everglades until finally trees find favorable living conditions, the small hammocks become larger, coalesce, and the trees become dominant.

FLOOR OF THE EVERGLADES

The Everglades almost everywhere has a rocky bottom, very nearly flat, but sloping at a rate of about one-tenth of a foot per mile toward the Bay of Florida and the Gulf of Mexico. Under these waters the floor continues oceanward and reappears in the Florida Keys. The northernmost part of the area, however, contains an original basin about 35 miles in diameter, with the deeper parts about at sea level, and in this shallow, wide depression is the second largest fresh water lake in the United States, Lake Okeechobee. The floor of the Everglades on the eastern, northeastern, and southeastern sides is almost perfectly flat-lying. Canal cuts show flat-lying beds of limestone for miles. But in the northwestern, western, and southwestern portions of the Everglades the floor appears to be wrinkled or warped into small undulations like those exposed in the banks along the Caloosahatchee River at Ortona locks and elsewhere (Figure 5). It is interesting to note that at least twenty of these small undulations can be counted in the river banks between Denaud and Lake Hicpochee.[2] These low undulations are elongated in a general north-south or northwest-southeast direction in the upper Everglades where they are visible in canal cuts, and it is possible that the location and trend of the elongate hammocks in the western parts of the Everglades are partly determined by these minor folds and partly by surface drainage.

GEOLOGY

Interest in the geology of this area began in the first half of the nineteenth century. Some of the foremost geologists of the world have worked in southern Florida, and the fine exposures of fossil-bearing beds along

[2] Dall, Wm. H., Neocene of North America, U. S. Geological Survey Bull. 84, 1892, p. 146.

the Caloosahatchee River caused several of these scientists to give particular attention to that area. Elsewhere in this section of the State, however, the geologic data were more difficult to gather because of the combination of low, flat terrain with few and very shallow river cuts, the difficulty of transportation, the lack of cuttings from deep or shallow wells, and the mantle of muck, marl, sand, water, and vegetation that covers the underlying rocks. The investigations of early workers were necessarily restricted to the margins of the peninsula and along the shallow river banks.

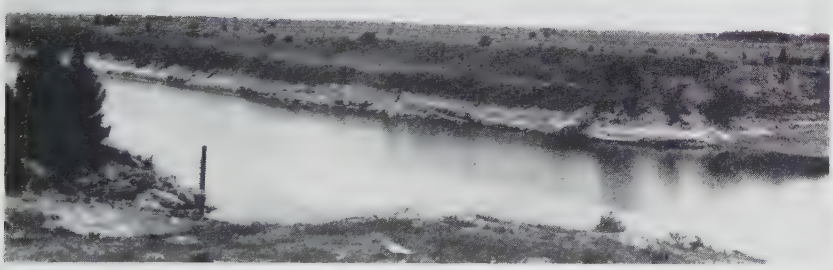

Figure 5.—Looking at the south bank of the Caloosahatchee River across from the U. S. Engineer Reservation at Ortona Locks, Fla. The rocks are of the Fort Thompson and Caloosahatchee formations and show a small anticline rising above water level at the prow of the boat. The apex of this small flexure is located where the pipe line is seen plunging below water level.

Notable among these early workers was Louis Agassiz[3] who, in 1851 wrote the theory, later enlarged upon by Joseph LeConte and incorporated in his Elements of Geology, 1878, that peninsular Florida southward from about the latitude of Tampa and Winter Haven had been formed by the successive growth and detrital burial of coral reefs. He supposed that these reefs had grown across a sea bottom not deeper than 12 to 20 fathoms, and that the action of waves and wind had caused them to be buried by sand and other detritus to a height of a few feet above sea level. All this he supposed took place without changes in the relative level of sea and sea bottom. He believed that Florida has ceased to expand in this fashion because the depth limit had been reached at which corals can grow and produce reefs.

But Agassiz and LeConte never would have proposed such a theory had the mass of data been available which modern geologists now have at hand. This comes from many sources; especially from the miles of excavations made in building roads, canals, ditches, and dikes. These excavations, though generally shallow, serve to expose the formations through which they are cut and to make available for study the rocks and fossils which compose the spoil banks and road beds. Furthermore, the numerous ex-

[3] Agassiz, Louis, Fla. Reefs, Keys, and Coast: U. S. Coast Survey Rept. for 1851.

ploratory wells for oil and the large number of water wells (Figure 6) have added greatly to the knowledge of the structure, stratigraphy, paleontology, and hydrology of this area. Much of this information, especially concerning hydrology, has become available only since Cooke and Mossom's[4] comprehensive geological report of Florida was published.

Figure 6.—Looking south along Snapper Creek at the drilling operations of G-218. The crew is seen dumping the bailer in a spillway, and the cuttings and water are collecting in the four gallon bucket. In the left-hand corner is the volumetric box and 550 gallons-per-minute pump used for pumping tests. Crew averaged 40 feet of 6-inch diameter well per day. Record was 94 feet.

STRUCTURE AND STRATIGRAPHY

In southern Florida a thickness of more than 10,000 feet of sedimentary rocks is present according to the record[5] of an exploration well for oil, S-396, drilled 10,006 feet deep about 50 miles west of Miami. Campbell[6] reports that the well ended in Lower Cretaceous strata comparable to the Fredericksburg group of Texas and southern Oklahoma, and suggests that this area is underlain by still older sedimentary rocks.

The sedimentary formations, as described by Mossom[7], form a broad, elongated arch or anticline that trends in a southeasterly direction and plunges to the southeast in southern Florida. On its crest, in northwest peninsular Florida, this huge dome is breached by erosion, exposing the Ocala limestone of Eocene age. Flanking the Ocala as it dips under them are younger geologic formations of Oligocene and Miocene age, which slope away in all directions, generally thickening seaward; and because of this structural relationship and the permeability of the limestone, the

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[4] Cooke, C. Wythe, and Stuart Mossom, Geology of Florida, Fla. Geol. Survey 20th Ann. Rept., 1928.

[5] Campbell, R. B., Deep Test Well in the Fla. Everglades: Am. Assoc. Petro. Geol. Bull., vol. 23, no. 11, Nov. 1939.

[6] Campbell, R. B., Outline of the geological history of peninsular Fla., Proceedings of the Fla. Academy of Sciences, vol. 4, pp. 87-105, 1939.

[7] Mossom, Stuart, A review of the structure and stratigraphy of Fla.: Fla. Geol. Survey 17th Ann. Rept., pp. 171-268, 1926.

Ocala and associated formations are notable artesian aquifers. In southern Florida these formations, including the Ocala, are thought to crop out on the floor of the ocean or gulf at some distance offshore, very close on the Atlantic side and at a much greater distance in the Gulf, and it is there that some of the artesian water may be naturally discharged. The younger formations of Pliocene and Pleistocene age are essentially horizontal and do not conform to the structure of the older formations. They do not contain artesian water but generally yield water to shallow wells.

FORMATIONS

Eocene Rocks

OCALA LIMESTONE

The Ocala limestone, of Eocene (Jackson) age, is the oldest and most deeply buried of all formations penetrated for water in southern Florida. It was present in the Campbell well, S-396, at 1,220 feet below the land surface. According to Mossom[8] it was penetrated at about 900 feet below the land surface in S-353 at Belle Glade, about 60 miles north of the Campbell well, and at 600 feet below the land surface in a deep well, S-423, at Okeechobee. It is exposed on the surface about 150 miles north of Okeechobee in Citrus, Sumter, and Marion Counties. From these figures it is apparent that in approximately 250 miles the Ocala dips about 1,220 feet, or almost 5 feet per mile; however, it is doubted that the dip is uniform throughout this distance.

The Ocala is essentially a soft white limestone composed largely of the tests of foraminifera, but it contains also many more or less well pre-

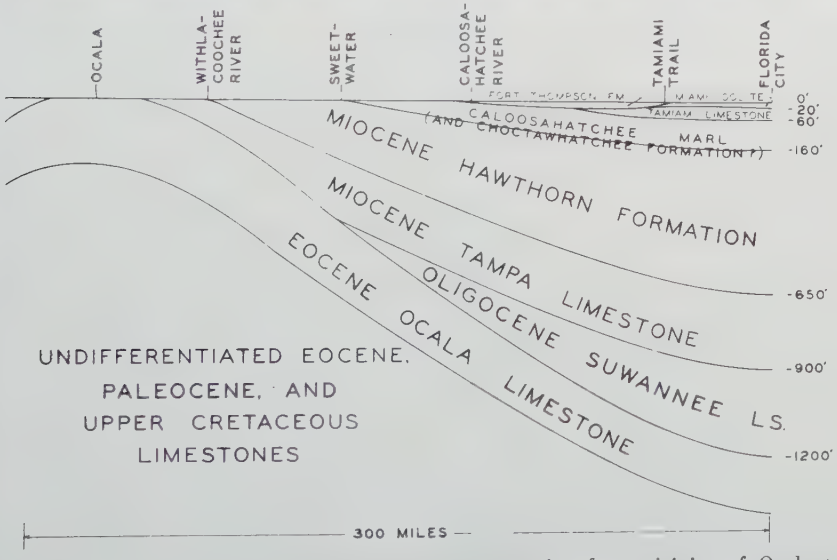

Figure 7.—Generalized north-south geologic cross section from vicinity of Ocala to Florida City, Fla. (Greatly foreshortened.)

[8] Mossom, Stuart, *op. cit.*, p. 251, 1926.

GEOLOGICAL FORMATIONS IN THE EVERGLADES.

Age	Formation	Character	Thickness in feet
Recent	Lake Flirt marl of Sellards	Undifferentiated sand, soil, muck, and soft gray marl.	0-20?
		Fresh water marl and limestone, thin, case hardened facies very hard.	0-3?
Pleistocene (Contemporaneous in part)	Fort Thompson formation	Marine shell marl, thin, overlies and fills solution holes in underlying limestones and marls (Coffee Mill Hammock marl of Sellards).	0-6?
		Alternating fresh, brackish, and marine limestones and marls. Yields water to shallow wells.	0-10?
	Anastasia formation	Coquina, sand, calcareous sandstone, sandy limestone, and shell marl. Yields water to shallow wells in coastal area of Palm Beach County and northward.	0-30?
	Miami oolite	Limestone, soft, white to yellow, containing streaks or thin layers of calcite; generally cross-bedded and stratified; perforated with vertical solution holes. Yields water to shallow wells.	0-30?
Pliocene	Tamiami limestone	Calcareous sandstone, sandy limestone, and beds and pockets of quartz sand. Contains many solution holes, generally filled with fine white quartz sand. It is the principal aquifer in southeastern Florida and yields copious supplies of water with slight drawdown to numerous wells, especially in the coastal zone.	0-100?
	Caloosahatchee marl	Sandy shell marl in places grading into pure sand or greenish clay. Parts are consolidated into a sandstone. Yields mineralized water to wells in the Lake Okeechobee area and southward in the Everglades. Little used because of low permeability and poor quality of its ground water.	25-100?
Miocene	Hawthorn formation	Green and gray sands, sandy marls, silt marls, clay marls, and phosphatic gray limestone. Green colors common in these sediments. Unconsolidated portions often are troublesome to drillers due to their tendency to "heave" or "cave" during drilling. Contains little water, some of it under low artesian head. Quality of water is poor. Is an aquiclude rather than an aquifer.	400-550?
	Tampa limestone	White to tan or gray limestone, calcareous marl, and thin beds of sand and shell. Artesian water is available in most parts of this formation, but in the Everglades area the quality is poor or bad.	250-350?
Oligocene	Suwannee limestone	White to cream-colored limestone, granular to dense, compact. Carries relatively highly mineralized and corrosive artesian water.	200-300?
Eocene	Ocala limestone	White, cavernous limestone that is cherty in places. Yields relatively highly mineralized and corrosive artesian waters.	500-?
Eocene Paleocene and Cretaceous		Undifferentiated calcareous, gypsiferous and anhydritic sediments.	?

served fossils of larger marine animals. In places beds of chert are present. The formation is probably about 500 feet thick in the southern part of the state, thickening from the outcrop area seaward.

As an aquifer the Ocala is well known. Such large springs as Silver Springs and Rainbow Springs issue from the cavernous limestone of this formation. Silver Springs alone, as measured by the Federal Geological Survey[9] flows at times more than 22 million gallons per hour (822 second-feet). Rain water enters the Ocala in its outcrop area or in areas where permeable rocks overlie it and permit downward percolation. That part of the water which does not return again to the surface as a spring or seep, or by evaporation or transpiration, or is lost by some other means, as from wells, slowly flows through the formation, gradually dissolving minerals from the enclosing rocks, and becoming more and more highly mineralized. By the time this water has progressed to the area of the southern Everglades it is more than 1,200 feet deep, and has become so highly mineralized that it is unfit for domestic or public consumption. Of over a dozen wells drilled in the Miami area to tap these artesian waters none are now in use, principally because of the corrosive action of the water. All wells penetrating the Ocala in southern Florida are artesian.

Oligocene Rocks

SUWANNEE LIMESTONE

Visible on the surface in the northeastern part of Hillsborough County along Blackwater Creek[10] is the southernmost exposure of the Suwannee limestone, of middle Oligocene age, which was deposited in a shallow sea that covered all of peninsular Florida except for a large island that existed in the northeastern part[11]. Earlier and later during Oligocene time it is likely that Florida was largely an area elevated above sea level, so that no sediments were formed on the present land area; rather erosion took place.

The Suwannee limestone "is a granular to dense, compact, usually cream-colored, rather pure limestone."[12] It unconformably overlies the Ocala limestone, though is often overlapped and covered by younger formations so that it is hidden from view (Figure 7). In southeastern Florida it is about 900 feet deep and 300 feet thick. The water-bearing characteristics of the Suwannee limestone are not well known. Wells penetrating the Suwannee are now generally in bad repair, the casings are leaky, and it is probable that water samples obtained from wells ending in the Suwannee are a mixture of waters from several different water bearing strata. Water thought to be coming under artesian head from the Suwannee is highly mineralized and unsuitable for most human uses. None of the Federal Geological Survey test wells has penetrated the Suwannee limestone.

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[9] Meinzer, O. E., Large Springs of the United States: U. S. Geol. Survey Water Supply Paper 557, p. 12, 1927.

[10] Mansfield, W. C., Molluska of the Tampa and Suwannee limestones of Florida, State of Fla. Dept. of Conservation, Geol. Bull. 15, p. 61, 1937.

[11] Campbell, R. B., Outline of the Geol. Hist. of Florida: Proc. Fla. Acad. Sci., vol. 4, pp. 102-103, 1939.

[12] Mansfield, *op. cit.*, p. 46.

TAMPA LIMESTONE

The characteristics of the two Miocene formations recognized in southern Florida indicate very different conditions prevalent during their deposition. The older of these, the Tampa limestone of lower Miocene age, is 150 to 250 feet thick, probably thickening seaward from its outcrop areas. It was formed in a warm, shallow sea containing at least one large island located in the general vicinity of northeastern Florida. This is indicated by a study of Dall's report[13] of the molluscan fauna collected from Ballast Point near Tampa. Dall reports 24 species of land and fresh water mollusks in addition to nearly 300 marine and brackish water forms. The

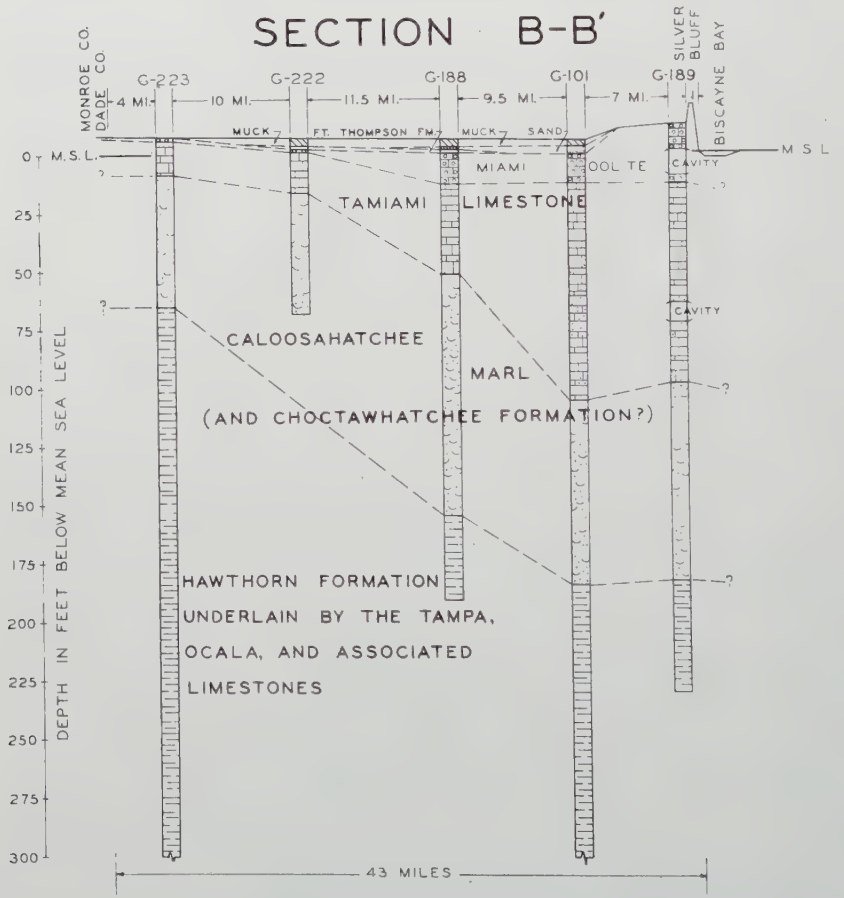

Figure 8. –Generalized west-east geologic cross section, B-B', Monroe-Dade County line to Miami.

[13] DALL, W. H., A monograph of the molluscan fauna of the Orthaulaux pugnax zone of the Oligocene of Tampa, Fla.: U. S. Natl. Museum Bull. 90, 1915.

sea was fairly clear so that a white to tan rather pure limestone was deposited in all but shore areas, where sandy facies are found.

In the Everglades area the Tampa is deeply buried (see Figure 7) in the southeastern and eastern part and only highly mineralized waters are found, generally under artesian conditions. Stringfield[14] reports that in the west-central part of the peninsula the Tampa is an important aquifer and yields large quantities of water to wells in Hillsborough and Pinellas Counties.

HAWTHORN FORMATION

The Hawthorn formation (of the Alum Bluff group) was deposited in a much more extensive sea than was the Tampa. It is present in all parts of peninsular Florida except where stripped away by erosion. Isolated patches of Hawthorn are found on the highest portions of the State as erosion remnants unconformably overlying the older formations. This indicates that at one time a continuous mantle of these Miocene deposits covered the peninsula and that all of Florida was below the level of the sea at the time that it was deposited.

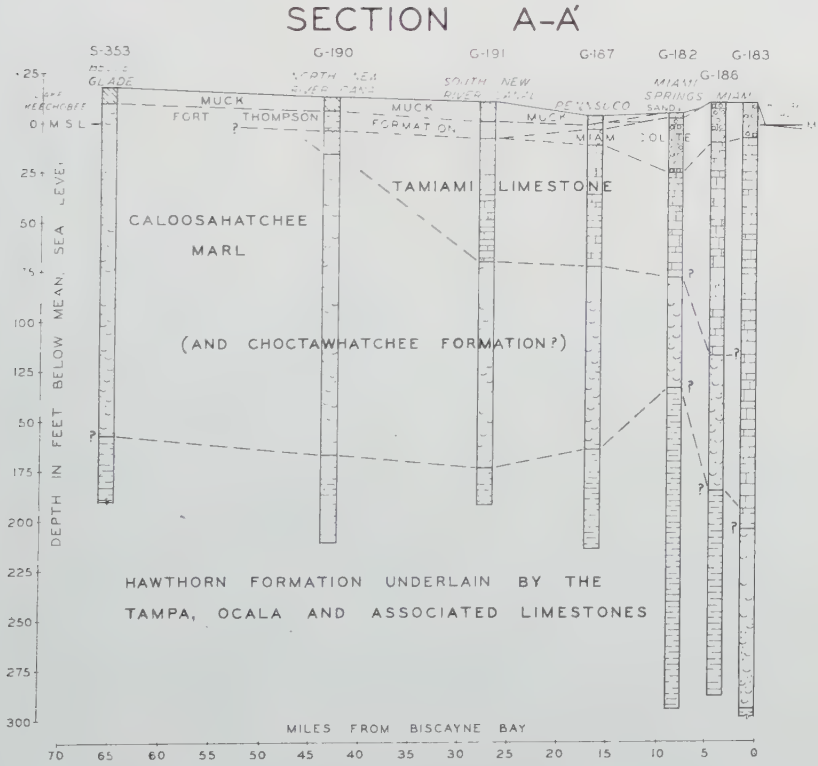

Figure 9.—Generalized north-south geologic cross section, A-A', Lake Okeechobee to Miami.

[14] Stringfield, V. T., *op. cit.*, pp. 15-16; also see U. S. Geol. Survey Water Supply Paper 773-C, p. 128, 1936.

The Hawthorn formation in southeastern Florida consists essentially of green and gray sands, green and gray sandy marl, green silt marl, green clay marl, and gray sandy phosphatic limestone. Within it fossil shell beds occur at random, and it contains a liberal amount of phosphatic sand grains, granules, and fine gravels. It is about 400-550 feet thick, and confines the artesian water in the underlying rocks. It bears limited amounts of water in its more permeable portions, some of it under low artesian pressure, thus it is an aquiclude, carrying water but preventing the upward percolation of ground water from below it or the downward percolation of ground water from above it.

The upper part of the Miocene in southeastern Florida includes beds that appear to be equivalent in age to the Choctawhatchee formation of northwestern Florida, but additional paleontological work is needed to establish that relationship. It is probable that sections now called Hawthorn or Caloosahatchee are in reality Choctawhatchee and overlie the Hawthorn and underlie the Pliocene Caloosahatchee marl. (See section on Caloosahatchee marl, pp. 60-63.

There are considerable differences in the quality of ground water in the Hawthorn formation. North of Lake Okeechobee small supplies of potable water are obtained from it[15]. Farther south, in the vicinity of Miami, the formation will yield only small supplies to wells, and the water is relatively highly mineralized. Chloride concentrations of several hundred parts per million are commonly found. However, water samples from test well G-223, a 600-foot well in the "Y" of the Tamiami Trail, about 40 miles west of Miami, indicate that different conditions prevail in the ground water of the Miocene rocks there. The chloride content of samples of water from the few permeable portions of that well ranged from about 30 to 67 parts per million. Water from some parts of the Hawthorn on the southwestern coast of Florida is also lower in chloride than that on the southeastern coast of Florida, but higher than that found in test well G-223.

Pliocene Rocks

caloosahatchee marl

Two Pliocene formations are recognized in southern Florida, the Caloosahatchee marl and the Tamiami limestone. The older of the two is the Caloosahatchee marl, a formation that is widely distributed throughout peninsular Florida, and is at or near the surface in the northern and parts of the western portion of the Everglades-Big Cypress Swamp area. It is exposed in the banks of the Caloosahatchee River (Figures 10 and 11) from the Fort Denaud area to the vicinity of Fort Thompson, and is buried at such shallow depths under the upper Everglades that dredging operations commonly expose its rocks and fossils in the spoil banks, often mixed with over-lying Pleistocene materials.

The Caloosahatchee marl is in general a wedge-shaped formation, (Figures 8 and 9) thickening seaward from its outcrop areas. In the lower Everglades area it, and shell marls of Choctawhatchee age that are very similar lithologically, are found to depths of about 150 feet below the

[5] Stringfield, V. T., *op. cit.*, pp. 15-16, 19-21, 31.

land surface, unconformably overlying the Hawthorn formation, and in this area they are generally of relatively low permeability so that, even were the ground waters in them potable, few wells could be developed therein.

Deposited in a warm, shallow sea the Caloosahatchee marl contains excellently preserved fossils of great variety and in huge quantities. Some parts of the formation are 90 percent mollusk shells, so that it is often

Figure 10.—Looking northeast along the south bank of the Caloosahatchee River at a point about 1½ miles south of Fort Denaud. The place is a few rods northeast of the mouth of Banana Creek. The light colored beds are a green-gray clayey phase and a gray calcareous marly section of the Caloosahatchee marl, here exposed to about 6 feet above the water surface. The overlying beds are Pleistocene sands, and their contact marks the unconformity between them.

Figure 11.– Showing detail in the lower beds of figure 10, the Caloosahatchee marl. This is in the gray, calcareous marl section. Shown is the broken-off end of a cetacean rib (whalebone whale) as found in place. Near spinal end of the rib a portion of the basal attachment of a barnacle is to be seen, indicating that the rib lay on a shallow sea bottom before burial took place. Numerous *Pecten* and *Lucina* fossils are found in this section.

aptly called a shell marl. Other parts of the formation are clayey, marly, or sandy; in places the lateral gradation from one lithologic type to another takes place in a very short distance. Lenses of almost 100 percent quartz sand occur. The whole appearance of the formation is that of one formed on a shallow sea bottom with constantly shifting shores and current conditions.

Water supplies are developed in the Caloosahatchee marl to a limited extent in the area surrounding Lake Okeechobee[16], but in some areas the water is relatively highly mineralized. Furthermore, these mineralized waters in the Caloosahatchee extend southward under the Everglades. (Figures 2 and 12).

The chloride content of samples of water from test wells in the Everglades differs from place to place, largely depending upon local permeability of the rocks, but mainly depending upon distance from the lake and depth below the land surface. This is illustrated by tables 1, 2, and 3. A record of the wells from which samples of water were collected from different depths as the wells were drilled is given in table 1. The results of chloride tests on deep wells in a general north-south line from the North New River Canal 12.2 miles north of the 20 mile bend to the Tamiami Trail at Krome Avenue are included in table 2. Table 3 shows the results of chloride tests on samples of water from a line of 1¼-inch diameter shallow wells located at six-mile intervals along the Miami Canal beginning at the north at the intersection with the Bolles Canal and continuing southeasterly to the end of the unexcavated portion of the Miami Canal about a quarter of a mile northwest of the confluence of the South New River and Miami Canals. Figure 12 graphically shows the differences in chloride concentration in these test wells.

The chloride in the water samples collected from these wells, in rocks of probable Caloosahatchee age, show about the same type of occurrence, viz., greater concentration at depth and in the northern portion of the area near Lake Okeechobee. This concentration may have been brought about by occasional sea invasions of this area in the Pleistocene, probably coinciding with interglacial stages. Salt water filled the lake, which was then considerably larger than it is now, probably extending west to LaBelle, east to the coastal ridge, and south to the vicinity of Tamiami Trail. Being heavier than fresh water it gradually seeped down in the rocks under and surrounding the lake, generally moving down gradient to the south. In the Miami area the salty water has been almost flushed out (see graph, well G-187, Figure 12), but in the Lake Okeechobee area the mineral content is relatively large. This is because the rocks at equivalent depths in the lake area are less permeable than in the Miami area; furthermore, the salt may have been almost flushed out a number of different times, only to be renewed by later sea invasions and reconcentrated in the area near the lake. The least concentrated ground water and the most permeable rocks in the Everglades area lie to the east and south. In the upper parts of the Everglades it is probable that only limited amounts of ground water suitable for industrial and municipal use are available.

[16] Stringfield, V. T., *op. cit.*, pp. 16-17, 19-20.

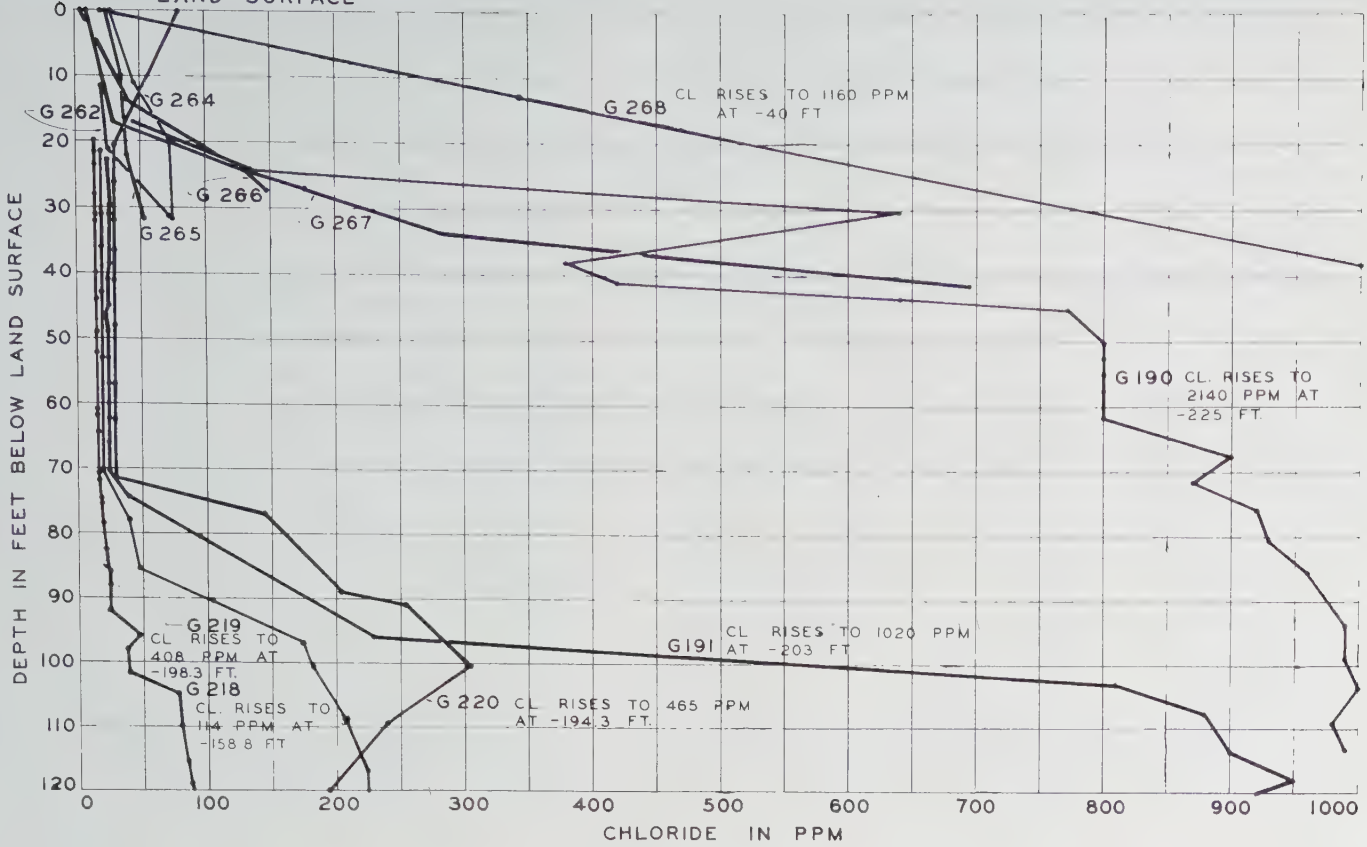
LAND SURFACE
DEPTH IN FEET BELOW LAND SURFACE
CHLORIDE IN PPM
0
10
20
30
40
50
60
70
80
90
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
G 262
G 264
G 266
G 265
G 267
G 268
CL RISES TO 1160 PPM AT -40 FT
G 190 CL. RISES TO 2140 PPM AT -225 FT.
G 219
CL RISES TO 408 PPM AT -198.3 FT.
G 218
CL. RISES TO 114 PPM AT -158 8 FT
G 220 CL RISES TO 465 PPM AT -194 3 FT.
G191 CL RISES TO 1020 PPM AT -203 FT

Figure 12.

Exposed on the surface of Collier and Monroe Counties along the Tamiami Trail beginning a few miles west of the Collier-Dade County line and extending westward at least 6 miles beyond Florida Route 164, and north along Florida Route 164 from the Tamiami Trail at least as far as the southern end of the Ocaloacoochee Slough, is a white or cream to brown sandy limestone and calcareous sandstone described and mapped by Sanford[17] as the Lostmans River limestone and considered by him to be of Pleistocene age, perhaps a little older than the Miami oolite. (Figures

Figure 13.—Looking at the north bank of the Tamiami Canal about 55 miles west of Miami. This is a typical view of the Tamiami limestone and shows the solution pitted appearance of the rock.

Figure 14.—A large piece of the Tamiami limestone dredged up in digging the canal. The location is about 48.5 miles west of Miami. Note the small fossils (white specks) and type of solution holes.

[17] Sanford, Samuel, The topography and geology of southern Florida: Fla. Geol. Survey, 2nd Ann. Rept., p. 222, 1909.

13 and 14). Cooke and Mossom,[18] however, suspected that the southern portion of the area should be correlated with the Miami oolite (Pleistocene), and that the northern portion is of Caloosahatchee age, and they so mapped it. Mansfield[19], in 1931, described fossil collections from the area bordering the Tamiami Trail and concluded that they represented a Pliocene fauna. He referred the deposit to the Caloosahatchee marl but later decided that there was basis for separating the rocks of this area from the Caloosahatchee and called them the Tamiami limestone[20] which he tentatively considered to be older than the Caloosahatchee.

The writer, however, has traced the Tamiami eastward to a place near the Collier-Dade County line, where it passes beneath a thin cover of Miami oolite and muck, marl, and sand; and also has traced it northward along the Immokalee road (Florida 164) from the Tamiami Trail to where it feathers out above sands of Caloosahatchee age. Furthermore, cuttings from test wells show that underlying the Tamiami, where it is overlain by the Miami oolite, are sands and shell marls of the Caloosahatchee, thus making the Tamiami the younger of the two Pliocene formations. See cross sections, Figures 8 and 9.

In the area along the Tamiami Trail, near and west of the Collier-Dade County line, Miami oolite can be seen in contact with the Tamiami, filling old solution holes in it. This relationship is diagrammatically shown in Figure 15. Also along the Miami Canal between the county line dam and the unexcavated portion, and along the South New River Canal and Florida

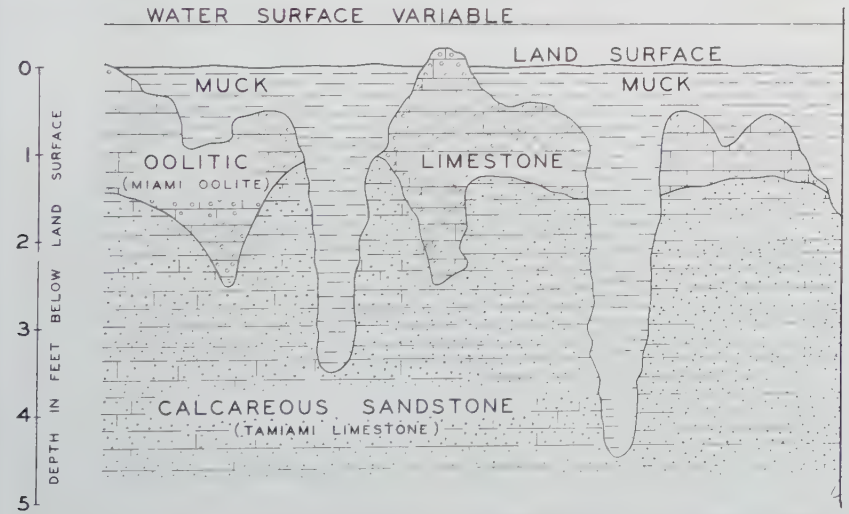

Figure 15.—Cross section showing relation of the Miami oolite to Tamiami limestone near 40 Mile Bend in the Tamiami Trail, western Dade County.

[18] Cooke, C. W., and Stuart Mossom, Geol. of Fla.: Fla. Geol. Survey 20th Ann. Rept., p. 207, 1929.

[19] Mansfield, W. C., Pliocene fossils from limestone in southern Fla.: USGS Prof. Paper 170-D, pp. 43-57, 1931.

[20] Mansfield, W. C., Notes on the upper Tertiary and Pleistocene mollusks of peninsular Fla.: State of Fla. Dept. of Conservation, Geol. Bull. 18, p. 8, 1939.

Route 26, the same relationship is found in big rock fragments along the spoil bank.

The Tamiami changes radically to the east as it thickens seaward, becoming in general a series of light colored sandy limestones, calcareous sandstones and beds and pockets of quartz sands. These rocks range in thickness from a feather edge up to 150± feet and are, in general, very highly permeable, yielding copious supplies of water to wells with exceptionally small drawdown. They have the general shape of a wedge, thin toward the interior and thick toward the coast. Inland they consist of more sand than in the Miami area and often are composed of so much fine sand that it is difficult to develop in them wells without a screen, though this is commonly done shoreward. All large supplies of the coastal municipalities of southeastern Florida are obtained from wells, generally finished without screens in this highly permeable aquifer.

The extent of the Tamiami under the Everglades proper is unknown at present, but it is probable that it pinches out a few miles north of the Tamiami Trail in the western Big Cypress Swamp, that it swings in an arc northward roughly paralleling the Atlantic shore and pinches out to the west about 35 miles inward in the latitude of Fort Lauderdale. It has not been traced farther north, but it may be that the rocks under the Delray well field, as sampled in well S-394, from 43 feet to 109 feet belong to this formation. Lithologically they are very similar.

These rocks and their fossils indicate a very warm, shallow sea deepest to the east and south. The shore line of this sea probably followed roughly the line indicated above in limiting its inland boundary. Also indicated is an elevation above sea level, following its deposition, with erosion and solution taking place. A subsequent return of the sea brought about deposition of the Miami oolite in these solution features as referred to earlier. Another solution feature probably developed at this same time is Deep Lake, a circular body of water about 100 yards in diameter located about 300 yards east of Florida Route 164 and 9.8 miles north of the Tamiami Trail (U. S. 94). Deep Lake is a typical sink hole, having precipitous walls 35 to 50 feet deep, then sloping off rather uniformly to about 97 feet below the average height of the surrounding rock floor of the Big Cypress Swamp. However, the Miami sea did not extend this far north, and only the solution-riddled Tamiami rocks are seen surrounding Deep Lake.

Pleistocene Rocks

MIAMI OOLITE

The Miami oolite, a soft white to cream-colored oolitic limestone of Pleistocene age, is present in the southern and eastern portions of the Everglades, where it is overlain by sand, muck, and marl. It is a thin formation, ranging in thickness from a feather edge in the interior to about 30 feet on the coast. Also, in a narrow zone where it is thinnest in the Everglades a hard fresh-water limestone possibly of the Fort Thompson formation, as much as 2 feet thick overlaps it.

The Miami oolite extends as a more or less continuous limestone "ridge" from the vicinity of Boca Raton southward. It forms the floor of the Bay of Florida and is the surficial rock of the lower keys, Big Pine

Key to and including Key West. This "ridge" is breached in certain narrow courses transverse to the coast. In the area as far south as Miami these transverse courses are underlain by sand, with little or no rock as deep as about 100 feet. Similar in appearance, certain "transverse 'glades" underlain by the oolite, are found south of Miami.

It is probable that the transverse sandy courses represent filled channels through which waters of old Pleistocene Lake Okeechobee were discharged, and through which at times tidal currents thoroughly scoured out loose sediment. With the final withdrawal of the sea, at the end of

Figure 16.—Typical appearance of the Miami oolite, with its cross-bedded, current-marked structure. The vertical solution holes are given scale by the six-year old boy. Site is an old borrow pit on the east side of highway U. S. No. 1 at the north edge of Fort Lauderdale.

Figure 17.—Looking northwest at the west bank of the Red Road Canal, west of Hialeah. The solution holes in the Miami oolite have taken up so much of the upper surface of the formation that only irregular remnants stand out where the sand has been washed away. This is typical of the oolite where it underlies the eastern part of the Everglades.

Pleistocene time, these old channels began to fill rapidly and to be choked with sand; and the basin of the old lake likewise became shallower by partially filling with sand, limestone, marl (of the Fort Thompson and related formations), and muck. Figure 18 shows the relationship of these materials to each other as typically developed.

The Miami oolite contains many vertical solution holes, or natural wells and is honeycombed with solution cavities, most of which are small, but some, as in test well G-189 near Silver Bluff (see Figure 2) are at least 10 feet deep. These solution holes are generally filled with sharp white quartz sand, and since the vertical solution holes occupy so much of the total volume of the oolite, ground water in the formation moves more freely in a vertical direction than laterally. (See Figures 16 and 17.)

Often referred to as "coral rock" the Miami oolite contains very little coral, and the few corals that are present are not reef-formers. Its fossils indicate a fauna that lived in a shallow, warm sea. Many of these fossils are in such condition today that one can infer that they died where they lived, i. e., they were not transported there. This, and the current cross-bedding features of the deposit, lead modern geologists to discard the old theory of eolian deposition, and to substitute instead the belief that the oolite was formed as a shallowly submerged bar subject to more or less tidal and current scour. It is quite possible, as Cooke[21] suggests, that this bar "shut off a wide shoal, only 10 to 25 feet deep, now the Everglades, from the deeper water of the Atlantic," and that "Lake Okeechobee marks a slightly deeper part of this epicontinental sea, its bottom in the deepest part being near present sea level, fifteen feet lower than the neighboring Everglades."

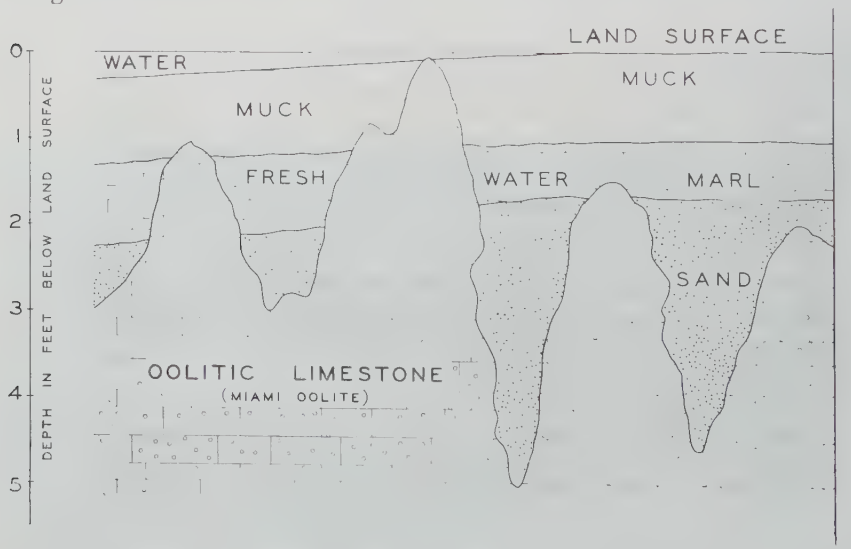

Figure 18.—Cross-section showing relation of peat, muck, marl, and limestone in the Everglades one mile west of Miami Springs.

[21] Cooke, C. Wythe, Scenery of Florida: Fla. Geol. Survey Bull. No. 17, p. 57, 1939.

ANASTASIA FORMATION

The Anastasia formation was probably deposited contemporaneously with the Miami oolite and as a sandy facies of it. It is found as a continuation of the coastal ridge north of Boca Raton, near which place the two formations grade into one another. It is a sand, shell, and coquina deposit on the whole, with some sandy limestone and calcareous sandstone in minor quantities. Its thickness is not exactly known; estimates range with maximums of 40 to 110 feet. It is a wedge-shaped deposit, like the Miami oolite, and extends northward as a narrow coastal strip to Anastasia Island, its type locality, near St. Augustine.

Wells are often constructed in the rocky portions of this formation without having to make use of screens, but since the rocky portions constitute a minor part of the formation, the majority of wells are of the screen or well-point type. Some gravel-pack wells are made in the sand or coquina. The quality of the water is different in different places but the occurrence is very similar to that described for the Miami oolite section. The permeability in the Anastasia is generally lower, however.

FORT THOMPSON FORMATION

The Fort Thompson formation is an alternating deposit of fresh-water, brackish and marine limestones, and marls. The type locality is at old Fort Thompson, about two miles east of LaBelle, on the Caloosahatchee River (see Figure 19).

Figure 19.—Scene looking westward along the south bank of the Caloosahatchee River at the type locality of the Fort Thompson formation, about 2 miles east of LaBelle.

A thin formation, probably not averaging 10 feet in total thickness, the Fort Thompson was formed in a shallow basin-like area, the deepest part of which is now occupied by Lake Okeechobee. At times this area was occupied totally by marine waters, and the sea animals of those days that lived there were so numerous that today their well-preserved shells make up shell marl layers a foot or more in thickness (Figure 20).

Then would come a time of withdrawal of the sea, probably one of the glacial stages of the Pleistocene, and the gradually freshening waters of old Lake Okeechobee would become brackish, and a fauna adapted to this kind of water would develop there. Finally, with complete freshening of the lake, fresh-water animals, like those of today, occupied the area. This sort of thing was repeated several times, likely coinciding with glacial stages. The next to the last phase of the Fort Thompson, and the most widespread one in the Everglades, however, is represented by an exceedingly hard fresh-water limestone, averaging about 2 feet thick, containing numerous fresh-water gastropods, especially of the genera *Helisoma* and *Ameria*. This rock represents the greatest extent of the fresh water lake and extended roughly from LaBelle east to the coastal ridge and from Okeechobee south to about the Tamiami Trail. The borders are most difficult to trace, but it is probable that the lake lasted longest in the eastern half of the Everglades, where the hard fresh-water limestone is best developed.

Figure 20.—Details in the Fort Thompson formation shown at the same place where figure 19 was taken. Note the solution holes averaging 4 inches in diameter in the upper bed, a fresh water limestone that contains many Ameria and Helisoma species, and is very hard. Under this bed is a marine shell marl containing many fine fossils, (note the well-preserved Pecten shells). This bed is soft and easily eroded. The end of the hammer handle rests on a three-foot thick fresh-water shell marl which is not so hard as the top bed. All these beds dip below the water farther upstream.

This rock is now largely altered by secondary processes of solution and redeposition. It is riddled by vertical solution holes averaging 4 inches in diameter as seen in canal cuts. It is hard to excavate, requiring blasting, and is difficult to chip with a hammer, breaking semi-conchoidally and ringing under the hammer blows.

Ground water in the Fort Thompson is developed in shallow driven wells around Lake Okeechobee. According to Stringfield[22] "some of the most suitable water obtained from wells for domestic use at Pahokee apparently comes from this formation. Recharge of the formation is in part

[22] Stringfield, V. T., *op. cit.*, p. 18-19.

local. and in some localities the formation yields water with a swamp coloring."

SUMMARY

The Everglades of Florida. an area of organic soils, lies between two slightly higher areas on the west and east and contains. in the northern part. Lake Okeechobee. the second largest fresh water lake in the United States. The floor of the Everglades is essentially flat and is overlain by a fairly uniform mantle of muck and peat about 8 feet thick in the north and gradually thinning out to the east. west. and south. The Everglades encompass about 4.000 square miles of saw grass marsh with numerous hammocks of willow, myrtle, and bay trees.

The organic soils of the southern and southeastern part of the Everglades are underlain by the Miami oolite and sands of Pleistocene age. and calcareous sandstone and sandy limestone of the Tamiami limestone of Pliocene age. The oolite is a thin wedge of limestone with many vertical solution channels filled with sand. It is cut through by sandy channels of Pleistocene age in many places north of Miami. Often no rock is present as deep as 100 feet in these courses. The Tamiami limestone crops out in the southwestern Everglades and Big Cypress Swamp. It is a wedge-shaped formation that dips toward the coast, and is the principal aquifer of the southeastern Florida coastal cities. The calcareous sandstones and sandy limestones of this formation are among the most permeable rocks ever investigated by the Federal Geological Survey.

In the northern part of the area the organic soils of the Everglades are generally underlain by the Fort Thompson formation of Pleistocene age. which has an average thickness of about 10 feet, and consists of freshwater. marine and brackish-water limestones and marls. The Fort Thompson formation is underlain by the sandy, shelly Caloosahatchee marl of Pliocene age. which contains relatively highly mineralized water in the area on the south side of Lake Okeechobee. This mineralized water is somewhat less concentrated toward Miami. The highest concentrations are near or at the base of the formation where it overlies the relatively impervious beds of the Hawthorn formation. The Hawthorn formation of Miocene age is 400 to 550 feet thick, and yields only small amounts of water to wells. Some of the water is under low artesian pressure. The formation confines the highly mineralized waters of the deeper and older artesian aquifers underlying it, the Tampa limestone of Miocene age, the Suwannee limestone of Oligocene age, and the Ocala limestone of Eocene age.

The Ocala is exposed in north-central Florida on the top of a huge, eroded anticline trending northwest-southwest and plunging to the south in southern Florida. It is about 1,200 feet deep in the latitude of Miami. The Oligocene and Miocene formations lap up on it, dipping away seaward in all directions; and because of this structure and their permeable rocks, they are notable artesian aquifers. The waters of these formations are not only highly mineralized in southeastern Florida, but are corrosive, rendering them unsatisfactory for most needs. However, in some parts of southwestern Florida satisfactory water is obtained from the Miocene formations. The water usually contains hydrogen sulfide and is hard.

TABLE 1.—Location of Test Wells in the Everglades.

Well No.	Location	Diameter (in inches)	Depth (in feet)
G-190	Florida Route 26, 12.2 miles north of the 20 mile bend in the North New River Canal	6	225
G-220	Florida Route 26, at the 20-mile bend	6	200
G-191	Florida Route 26, at the South New River bridge	6	204
G-219	Miami Canal at the county line dam, about 20 miles northwest of Miami	6	205
G-187	Miami Canal at Pennsuco, about 13 miles northwest of Miami	6	223
G-218	Snapper Creek Canal, 2 miles south of confluence with Russian Colony Canal, about 11 miles northwest of Miami	6	202
G-188	Krome Avenue, about 200 yards south of the Tamiami Trail, 19 miles west of Miami	6	200
G-268	Miami Canal at southeastern corner of intersection with Bolles Canal	1¼	41
G-267	Miami Canal, western side, 6 miles south of G-268	1¼	41
G-266	Miami Canal, western side, 12 miles south of G-268	1¼	27
G-265	Miami Canal, northern side, 18 miles south of G-268	1¼	32
G-264	Miami Canal, southern side, 6 miles southeast of G-265	1¼	31
G-263	Miami Canal, southern side, 12 miles southeast of G-265	1¼	20
G-262	Miami Canal, southern side, 18 miles southeast of G-265	1¼	31
G-261	Miami Canal, southern side, 24 miles southeast of G-265 and one-quarter mile above junction of Miami and South New River Canals	1¼	26
G-269	Miami Canal at county line dam	1¼	20

TABLE 2.—Chloride in Water of Deep Test Wells in the Everglades.

(Chloride in parts per million)

G-190			G-220		
Depth below land surface (feet)	Depth below mean sea level (feet)	Chloride	Depth below land surface (feet)	Depth below mean sea level (feet)	Chloride
17.1	2.8	44	20.5	9.9	32
19.7	5.4	42	32.0	21.4	31
24.1	9.8	106	36.6	26.6	32
			41.0	30.4	30
			44.9	34.3	28
31.6	17.3	640			
38.0	23.7	510	48.1	37.5	31
41.3	27.0	420	52.8	42.2	29
43.5	29.2	640	56.8	46.2	31
45.1	30.8	770			
49.8	35.5	800			
57.7	43.4	800	67.2	56.6	30
61.7	47.4	800	71.6	61.0	31
67.9	53.6	900	77.2	66.6	145
71.5	57.2	870	88.9	78.3	205
75.9	61.6	920	91.1	80.5	252
			100.3	89.7	305
			109.4	98.8	240
80.7	66.4	930	121.0	110.4	195
85.4	71.1	960	127.0	116.4	390
93.7	79.4	990	133.4	122.8	408
103.5	89.2	1,000			
109.2	94.9	980	139.4	128.8	408
			143.5	132.9	398
112.9	98.6	990	148.2	137.6	405
116.8	102.5	1,090	150.6	140.0	408
119.5	105.2	1,130	157.0	146.4	408
126.9	112.6	1,190	166.7	156.1	410
132.3	118.0	1,200			
138.8	124.5	1,230	172.0	161.4	415
144.0	129.7	1,340	180.2	169.6	432
149.0	134.7	1,260	184.0	173.4	452
154.7	140.6	1,260	190.3	179.7	445
162.0	147.7	1,450	194.3	183.7	465
			200.0	189.4	232
167.8	153.5	1,530			
181.3	167.0	1,580			
186.8	172.5	1,650		G-191	
192.4	178.1	1,800			
197.9	183.6	1,820			
			22.6	11.1	25
203.6	189.3	1,900	27.0	15.5	26
208.4	194.1	1,980	29.3	17.5	30
212.8	198.5	2,020	31.4	19.9	28
216.7	202.4	2,060	38.4	26.9	27
220.3	206.0	2,070			
			46.9	35.4	23
222.9	208.6	2,110	53.2	41.7	25
225.0	210.7	2,140	60.2	48.7	27

TABLE 2.—Chloride in Water of Deep Test Wells in the Everglades—*Continued.*

(Chloride in parts per million)

Depth below land surface (feet)	Depth below mean sea level (feet)	Chloride
68.0	56.5	26
70.5	59.0	27
74.4	62.9	31
80.1	68.6	92
95.9	84.4	230
102.6	91.1	820
107.5	96.0	880
113.6	102.1	900
117.9	106.4	950
123.1	111.6	870
129.5	118.0	930
135.7	124.2	970
143.0	131.5	1,040
148.0	136.5	1,030
154.0	142.5	1,050
158.7	147.2	1,050
166.7	158.2	1,030
172.8	161.3	1,060
179.3	167.8	1,020
183.5	172.0	1,020
186.2	174.7	1,000
190.1	178.6	1,000
193.3	181.8	1,010
196.0	184.5	990
200.2	188.7	990
203.7	192.2	1,020

G-219

21.6	10.2	19
30.1	18.7	19
42.9	31.5	20
53.2	41.8	20
55.8	44.4	19
76.5	65.1	40
88.6	74.2	48
90.5	79.1	105
97.2	85.8	174
100.7	89.3	182
108.3	96.9	208
117.0	105.6	225
121.2	109.8	225
134.0	122.6	230
143.4	132.0	270
157.5	141.1	270
161.9	150.5	290
166.6	155.2	345
173.3	161.9	282
178.2	166.8	308
181.7	170.3	300
184.8	173.4	395
191.3	179.9	315
198.3	186.9	408
205.0	193.6	302

G-187

18.3	10.6	23
26.1	18.5	23
33.5	25.8	23
41.7	34.1	23
51.3	43.6	24
59.1	51.5	23
69.5	61.9	23
80.3	72.5	24
85.6	78.0	27
91.1	83.5	27
98.3	90.7	35
105.6	98.0	65
113.6	106.0	63
121.7	114.1	54
127.5	119.9	67
132.6	125.0	64
134.9	127.3	69
139.5	131.9	67
149.8	142.2	67
155.2	147.6	69
160.8	153.2	61
166.3	158.7	57
171.8	164.2	57
178.0	170.4	57
179.6	172.0	53
183.6	175.9	45
187.4	179.8	47

TABLE 2.—Chloride in Water of Deep Test Wells in the Everglades—*Continued.*

(Chloride in parts per million)

Depth below land surface (feet)	Depth below mean sea level (feet)	Chloride
191.2	183.6	48
196.0	188.4	43
202.8	195.2	46
207.3	199.7	48
212.1	204.5	56
217.2	209.6	44
222.4	214.7	42
	G-218	
19.6	11.9	19
27.9	20.2	18
32.2	24.5	18
40.0	32.3	18
49.3	41.6	19
52.3	44.6	17
61.4	53.7	20
64.4	56.7	18
70.7	63.0	19
78.3	70.6	19
82.3	75.0	21
88.2	80.4	21
92.2	84.5	25
96.3	88.6	48
97.8	90.0	39
101.8	94.0	41
105.2	97.5	78
110.7	103.0	80
115.7	108.0	84
119.7	112.0	89
124.9	117.2	87
128.3	120.6	95
141.4	133.7	108
149.3	141.6	114
158.8	151.1	114
168.7	161.0	83*

*May be contaminated by surface water added for drilling. No more water samples obtainable to bottom of well at 202 feet below land surface.

Depth below land surface (feet)	Depth below mean sea level (feet)	Chloride
	G-188	
18.2	9.3	23
26.4	17.5	23
35.0	26.1	23
48.4	39.5	23
55.5	46.6	23
60.9	51.0	24
66.2	57.3	50
70.7	61.8	50
76.6	67.9	52
80.0	71.1	61
85.5	76.7	65
94.8	85.9	69
99.9	91.0	69
106.9	98.0	75
113.6	104.7	78
124.0	115.1	75
129.2	120.3	78
133.9	125.0	93
139.0	130.1	89
144.9	136.0	98
149.2	140.3	101
153.8	144.9	99
159.2	150.3	97
164.2	155.3	99
167.3	158.4	89
173.3	164.4	103
175.1	166.2	93
180.4	171.5	85
186.5	177.6	76
192.3	189.4	85
196.0	187.1	76
200.0	191.1	71

TABLE 3.—Chloride in Water of Shallow Test Wells Along Miami Canal in the Everglades.

(Chloride in parts per million)

Depth below land surface (feet)	Chloride
G-268	
0	19
12	345
41	1,160
G-267	
0	10
17	28
27	177
34	282
41	696
G-266	
0	9
14	39
24	127
27	147
G-265	
0	25
10	33
22	39
32	52
G-264	
0	27
11	45
20	71
31	75
G-263	
10	27
20	35
G-262	
12	20
21	26
31	71
G-261	
11	21
20	23
26	23
G-269	
20	19

THE PLAN AND PROGRESS OF RECENT SURFACE WATER STUDIES IN THE EVERGLADES

G. E. Ferguson*

FOREWORD

Those who are familiar with the Florida Everglades, and interested in the future development of that area, agree that further water control is one of its greatest needs. However, in order to bring about a more complete control, the existing hydrologic characteristics of the area must be changed to some extent. Doubtless all are familiar with the original, or natural, conditions that existed prior to the installation of the first improvement works, and how, under those natural conditions, water from the Kissimmee River and smaller basins to the north flowed into Lake Okeechobee, which in turn spilled water over its southern rim to inundate the Everglades for varying periods and in varying degrees. Owing to losses from evaporation and transpiration, only a part of the water originally falling in the Everglades and its contributing basins reached the ocean, directly as surface run-off.

Each development, or improvement, that has been made for the protection or economic benefit of the inhabitants has altered, to some extent, these natural characteristics. As development followed development, the hydrology of the area changed from the original or natural conditions, and probably became more complex. The improvements were successful to the extent that they followed designs based on accurate knowledge of the existing conditions of the water cycle—rainfall, evaporation, transpiration, and run-off. Of this cycle, a knowledge of the run-off is especially important, as it is that part of the cycle in which development works in the Everglades has made the greatest change.

As development of this area continues, the hydrology becomes more intricate and more difficult to accurately observe and record. But these observations and records continue to be a prerequisite to intelligent design of further development work, and therefore it is increasingly necessary that the hydrologic research be carried on.

BACKGROUND

Systematic studies of surface water and the collection of other basic hydrologic data in southeast Florida were begun in the fall of 1939 by the Surface Water Division of the Water Resources Branch of the Geological Survey, United States Department of the Interior. The studies were provided for under a 4-year cooperative agreement between the Geological Survey and the Cities of Miami, Miami Beach, and Coral Gables, and Dade

* District Engineer, Geological Survey, U. S. Department of the Interior, in charge of investigations of surface water resources of Florida, since 1941. Formerly Mr. Ferguson was engaged in similar activities with the Geological Survey over a wide area, including work in Ohio (1928); in Texas for the International Water Commission, U. S. and Mexico (1928-31); in Hawaii, mainly on studies of water supplies for sugar cane irrigation (1931-36); and in Washington and adjacent states (1937-40).

County whereby a program was arranged for the investigation of the water resources of Southeast Florida by the various Divisions of the Water Resources Branch. The primary purpose of the investigation was to study the adequacy and protection of present water supplies, and to determine the outlook for the future, just as far as possible, in terms of the growing requirements in this section of the State.

In January, 1941 the Geological Survey, after having been at work in this area for a little over a year, released its first progress report in which it submitted to the local cooperating parties, and to others interested in the results of the investigation, the basic data collected during 1939 and 1940, with certain interpretations and recommendations derived therefrom.

At the present time, this study has been in progress for nearly two years and a half. It is the purpose of this paper to present a brief description of that part of the investigation which relates to the activities of the Surface Water Division in its studies of hydrology and meteorology, and especially the relationship of this work to the conservation and reclamation problems in the Everglades area.

PLAN OF WORK

The general objective of the Surface Water Division in its part of the study is the collection and analysis of those basic hydraulic and hydrologic data which are pertinent and prerequisite to a complete understanding of the water-supply problems of the Miami area. More specifically, this objective has embraced the following procedures:

1. The observation and collection of data on rainfall, surface runoff evaporation, and transpiration during the period of the program.
2. The collection of all pertinent existing records, both old and current, for the above hydrologic elements.
3. The compilation and computation of these records in the required form for complete analysis.
4. The joint study and interpretation of the above records, together with other data collected by the Divisions of Ground Water and Quality of Water of the Geological Survey, for the purpose of an evaluation and determination of sources of water supply for the Miami area.

Although the objective of the investigation is a study of the water resources for the Miami area, it has been necessary in the proper pursuit of this objective to perform a considerable amount of general research work in the Everglades. This phase of the work will be emphasized in this description because of its important place in the future development of the Everglades. In fact, the general plan of this research activity is for the greater part similar to the foundation of a plan that might be constructed for the sole purpose of studying the water resources of the entire Everglades area. This similarity is not a coincidence, but rather is an example of the need in this area for basic hydraulic and hydrologic data.

PROGRAM OF WORK

As the activities under this program consist largely of studies of the characteristics of the water cycle, the work being accomplished under each element of this water cycle will be described.

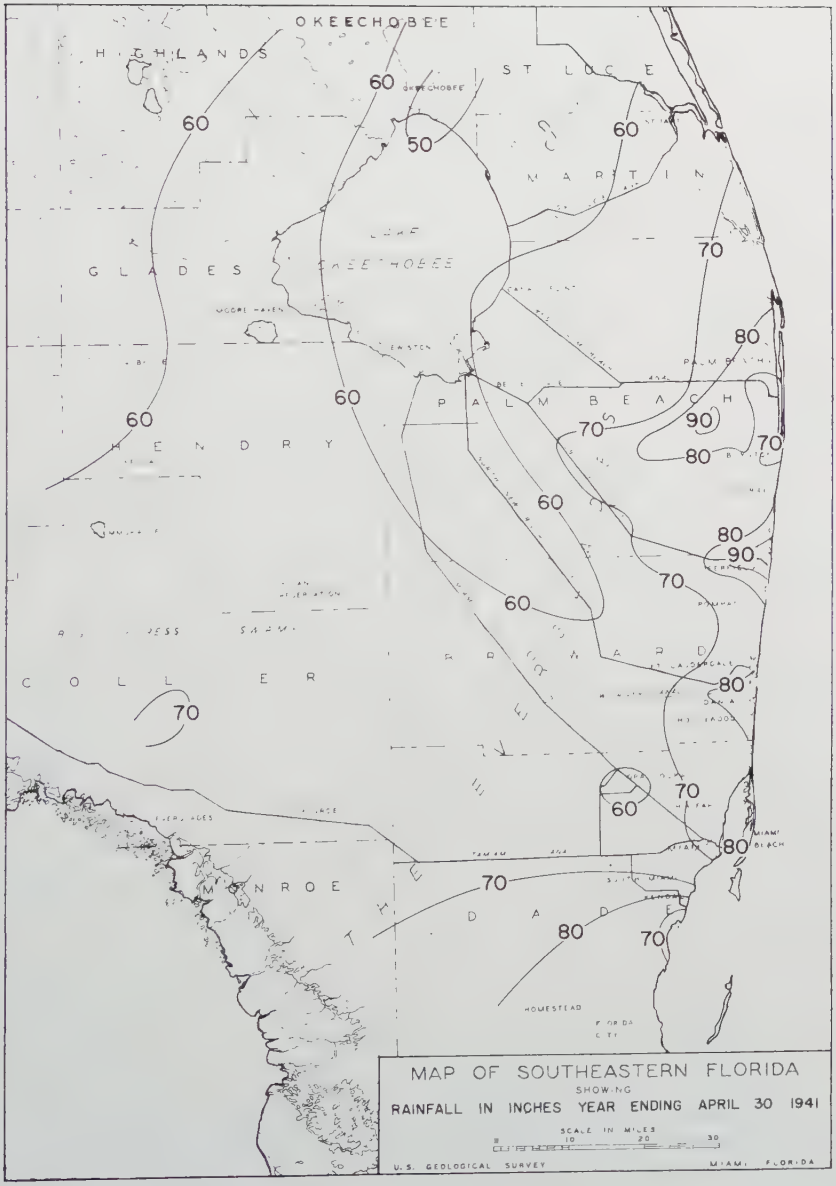
OKEECHOBEE
HIGHLANDS
ST LUCIE
MARTIN
GLADES
LAKE OKEECHOBEE
PALM BEACH
HENDRY
COLLIER
MONROE
DADE
60
50
70
80
90
MAP OF SOUTHEASTERN FLORIDA
SHOWING
RAINFALL IN INCHES YEAR ENDING APRIL 30 1941
SCALE IN MILES
U.S. GEOLOGICAL SURVEY
MIAMI, FLORIDA

Figure 1.

RAINFALL

Rainfall can be properly discussed first, as it is sometimes referred to as the beginning of the water cycle; at least it is thought of as being the source of water on the Everglades. Although rainfall is the element in this cycle over which the works of man have had the least control, it has had a long and comprehensive period of study.

In order to determine the amount of rainfall occurring over all or any part of the Everglades with an accuracy consistent with related data, records from all pertinent existing gages as well as from eighteen new stations established in areas of deficient coverage are compiled. These are used in the preparation of isohyetal maps showing total rainfall for particular periods under study. Such a map for the full year ending April 30, 1941 is shown as Figure 1. It is evident from an inspection of this map, that there is considerable variation in rainfall over the area, and that the total rainfall along the East Coast is generally greater than that farther inland.

Throughout this investigation an attempt has been made not only to work with other research agencies toward an interchange of data to prevent duplication of effort, but also to arrange for the prompt release by publication or otherwise of certain basic data. In this connection, rainfall records from gages operated under this study are forwarded promptly to the United States Weather Bureau for release in the form of daily rainfall values in its monthly climatalogical bulletins and in the form of daily and hourly values in its hydrologic bulletins.

RUNOFF

Runoff is that hydrologic element which the works of man control most directly and effectively. This is especially true in the Everglades where the retention and drainage works on an almost level terrain make possible great changes in runoff characteristics. Because of this fact, an accurate knowledge of the hydraulic characteristics on all major water courses in the area are of great value to further development.

Basic to such a knowledge are the continuous records of flow and stage obtained at gaging stations at certain strategic points along the major drainage canals in the area under study. These records serve directly in hydraulic design, and also as an index to which all special studies and hydrologic events in general are referred for a determination of the conditions of runoff at that time. The locations of gaging stations established for this study are shown on the map in Figure 2. In general, both ends of the major canals are provided with gaging stations.

Another important group of stations in this general area is also indicated in this illustration—those measured by the Geological Survey with funds provided through the U. S. Engineer Office at Jacksonville. The Corps of Engineers have a long-standing appreciation of the value of stream flow records, and these gages have been in operation for several years.

Records of flow in cubic feet per second from two of these gaging stations on opposite ends of the West Palm Beach Canal are shown in

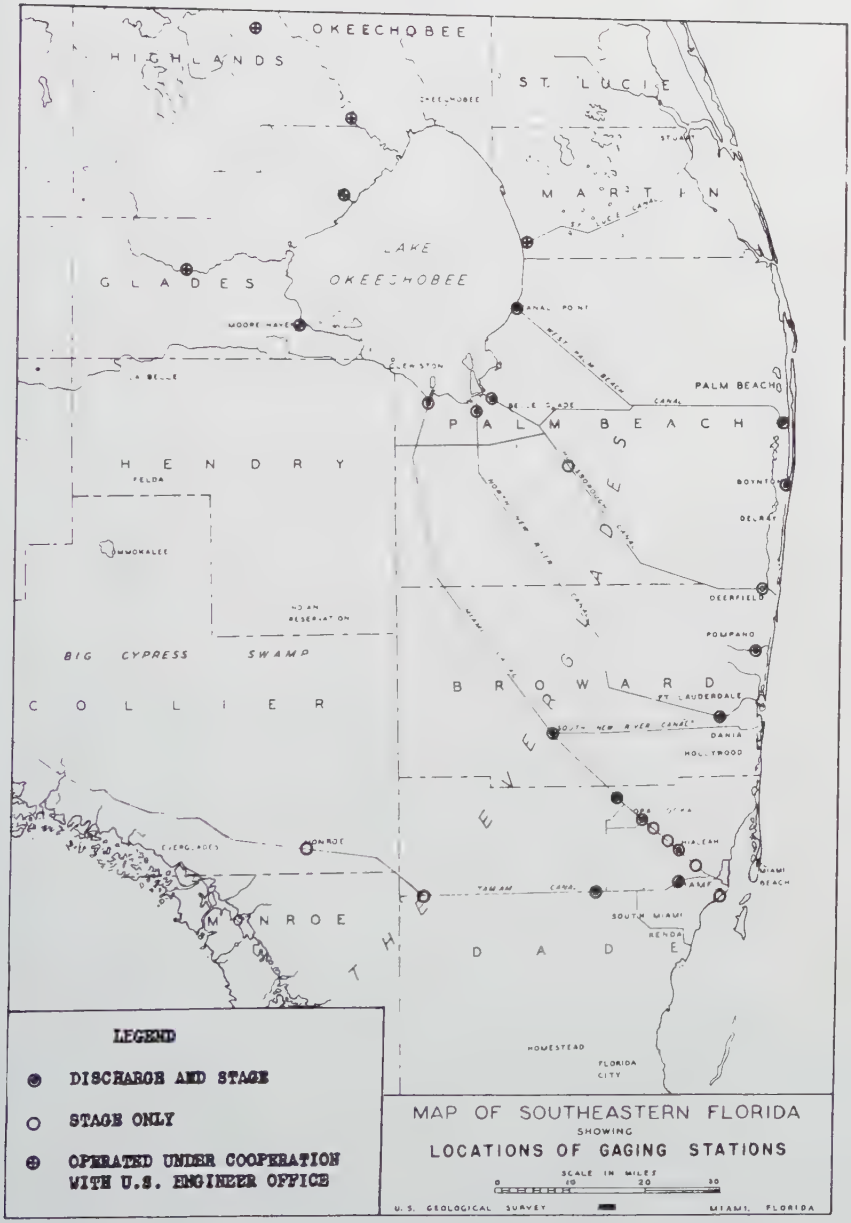
OKEECHOBEE
HIGHLANDS
ST. LUCIE
MARTIN
LAKE OKEECHOBEE
GLADES
PALM BEACH
HENDRY
BROWARD
COLLIER
MONROE
DADE
BIG CYPRESS SWAMP
LEGEND
DISCHARGE AND STAGE
STAGE ONLY
OPERATED UNDER COOPERATION WITH U.S. ENGINEER OFFICE
MAP OF SOUTHEASTERN FLORIDA
SHOWING
LOCATIONS OF GAGING STATIONS
SCALE IN MILES
U.S. GEOLOGICAL SURVEY
MIAMI, FLORIDA

Figure 2.

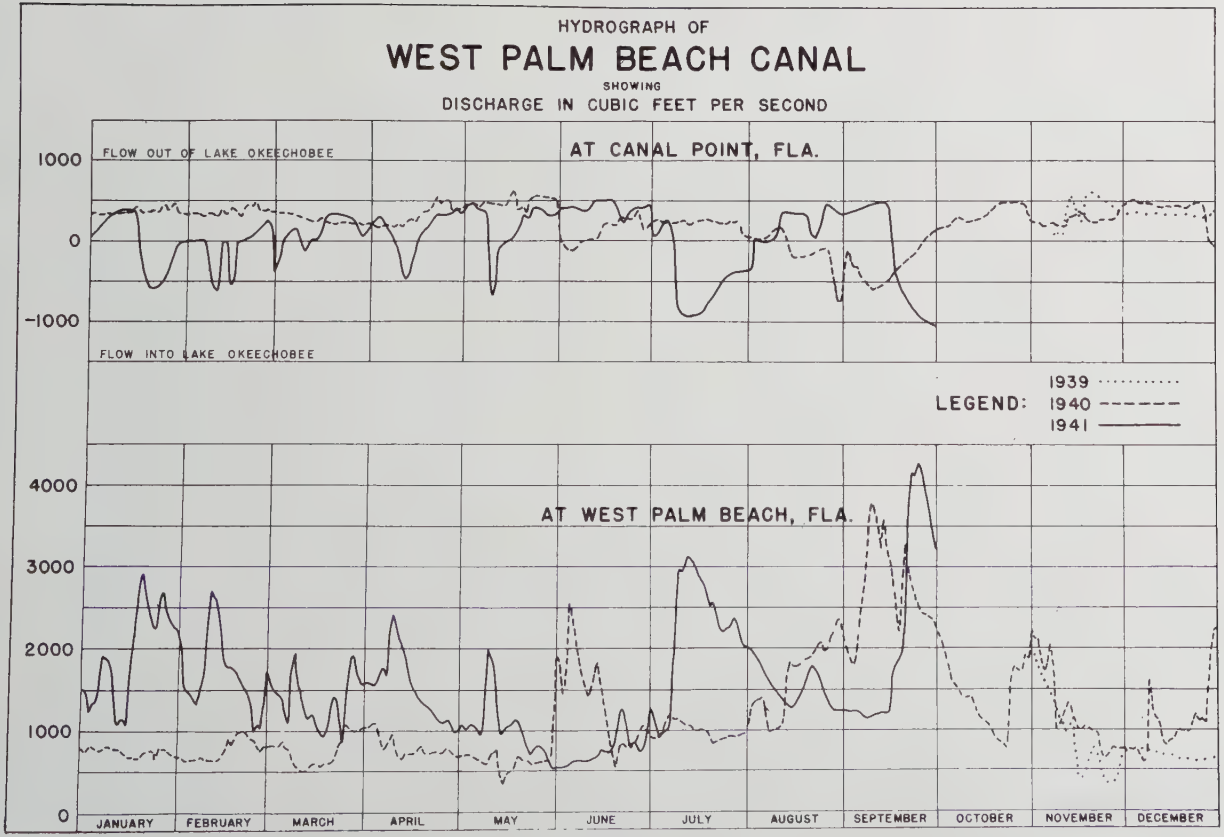
HYDROGRAPH OF
WEST PALM BEACH CANAL
SHOWING
DISCHARGE IN CUBIC FEET PER SECOND
AT CANAL POINT, FLA.
1000
0
-1000
FLOW OUT OF LAKE OKEECHOBEE
FLOW INTO LAKE OKEECHOBEE
LEGEND:
1939
1940
1941
AT WEST PALM BEACH, FLA.
4000
3000
2000
1000
0
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

Figure 3

hydrograph form in Figure 3. The difference in the characteristics of flow between the two is noticable. It is significant how the large variation between the different years of record at the same place makes it difficult to determine even approximate average runoff values without a considerably longer period of records.

EVAPORATION AND TRANSPIRATION

The effects of evaporation and transpiration, which play such a prominent part in the hydrology of the Everglades, are not only difficult to evaluate simultaneously under field conditions, but even more difficult to separate. Their effects are generally underestimated, as their forces act unseen. An illustration of the immensity of the evaporation factor alone can be made by referring to an interesting comparison.

The hydrograph of the West Palm Beach Canal near West Palm Beach, Figure 3, shows the flood flow during the latter part of September, 1941 the highest in this period of record. It is evident that such a large flow of water does not occur often at that place. However, the reports of the U. S. Engineers Office indicate that water is being evaporated from the surface of Lake Okeechobee during hot dry periods in the summer at about this same rate—over 4,000 cubic feet per second, or roughly two and one-half billions of gallons per day.

Four evaporation pans have been placed in operation during the period of this study, and the data obtained from them will be supplemented by records furnished by other agencies also operating evaporation stations in the vicinity.

SPECIAL STUDIES

Numerous special studies are being made from the basic data already collected. All of the studies are directly related to the research which must precede a large part of the future development in the Everglades area.

One class of special studies is concerned with the evaluation of the amounts of water placed on certain areas, and also removed from those areas, by the several hydrologic elements acting over a definite period of time. The partial completion of one of these studies makes it possible at this time to report such an inventory for the approximately 3,900 square miles of area south of the Lake Okeechobee and St. Lucie divide, north of Tamiami Canal, and east of the Everglades Drainage District natural divide, for the full year ending May 31, 1941.

The rainfall over this area during that period was nearly 67 inches, which is considerably above the average. Added to this was an amount equivalent to slightly less than one inch in depth over the area which constituted the net surface flow into the area through the drainage canals from Lake Okeechobee. This area, therefore, received a measured amount of water which averaged an equivalent of nearly 68 inches of depth over the 3,900 square miles.

As the water stored in and on the ground on May 31, 1941, was approximately equal to that similarly stored on May 31, 1940, it follows that between these dates the loss of water from the area must also have been about 68 inches. Of this total amount, over four million acre-feet of outflow, both into the Atlantic Ocean through the various drainage canals and

south across the Tamiami Canal, was measured. This measured outflow corresponded to nearly 19 inches depth of water over the area. The remaining 49 inches is believed to have been removed from the area largely by evaporation and transpiration, inasmuch as ground water movement both into and out of the area is at this time believed to be a small part of the total. Therefore, during the 12-month period, the drainage canals in the Everglades passed only slightly more than a quarter of the total water supply of the Everglades, evaporation and transpiration losses accounting for approximately three-quarters of the total.

It should be remembered, however, that these values, interesting and informative as they may be, are based on one particular 12-month period in which the rainfall was considerably greater than normal. Future studies of other periods will in time produce values that will better define the average conditions, as well as the range of deviation from the average.

VALUE OF HYDROLOGIC RESEARCH TO EVERGLADES DEVELOPMENT

Although the collection of these hydrologic data under the present program was begun only a little more than two years ago, a considerable demand for the information being collected has already developed among parties interested in various activities in the Everglades. This is especially true for the records of stage and discharge of the various canals. These data are furnished regularly to interested parties in provisional form for operational use, and at a later date, in more final form for use in special studies, planning, and design.

These flow records have already been used in the design of both sewage disposal and drainage works for Army airfields, thus contributing directly toward the war effort. The public welfare has been further served by the utilization of these records in the selection of a better source of municipal water supply, and in studies to improve facilities for drainage and irrigation in the great food producing areas of the Everglades.

The many requests received for these data, that are being collected, and other expressions of interest in the work, clearly indicate the large number of activities which will be benefited by a continuing program of this nature. A partial list of the known uses of these data is as follows:

- Drainage (agricultural)
- Irrigation
- Municipal water supply
- Flood control
- Fire control
- Soil surveys
- Land evaluation and tax studies
- Inland navigation
- Sewage disposal
- Frost control
- Fish and wildlife research
- Forestation studies
- Mosquito control
- Airport drainage
- Highway drainage
- Power production (condensing water)

CONCLUSION

The importance of further water control in the Everglades, and the great need for basic data to intelligently design for this greater degree of control, has been called to public attention many times in the utterances

and writings of well known authorities on this area. Reference is made to one article in particular. "The Soil and Water Conservation Problem in the Everglades" by Dr. R. V. Allison, 1939 Proceedings of the Soil Science Society of Florida, which ably describes the need for the collection and study of physical data for use in organizing a comprehensive unit plan of development for the Everglades.

The present cooperative agreement with the cities of Miami, Miami Beach, and Coral Gables, and Dade County will terminate on June 30, 1943. It has been anticipated that by then the amount of basic data collected generally over the Everglades will be sufficient for its particular use in the preparation of the report on the water resources for the immediate Miami area. It will not be sufficient, however, for the necessary definition of the water supply and runoff characteristics that will be vital in the successful design and study of future development in the general Everglades area. This is especially true of the records of flow in the major canals which should be continued for a sufficient length of time to include periods of extreme drought and flooding which have not yet occurred during the present program of study, and also to permit the determination of at least approximate average seasonal and annual runoff values.

It is anticipated that some state or local agency interested in the future development of the Everglades will see fit to arrange for a continuation of these records. The small cost of such a continuing program should be considered as an investment that will undoubtedly bring, through more successful and economical development, savings to the Everglades taxpayers amounting to many times the cost of the research program.

THE PLAN AND PROGRESS OF SOIL AND WATER CONSERVATION STUDIES IN THE EVERGLADES

C. Kay Davis*

This meeting provides an opportunity for technicians of the United States Geological Survey, the U. S. Engineers, War Department, and the Soil Conservation Service to acquaint you with their activities in the Everglades region of Florida. As with any other problem area of like proportions, our first objective has been the collection and analysis of physical and factual data; an appraisal, if you like, of the physical resources and geologic conditions. We believe this is the most important contribution which the Soil Conservation Service can make toward the organization of a definite plan for soil and water conservation and the orderly development of the Everglades.

One of the first things we attempted to do when the Soil Conservation Service entered the Everglades, was to synthesize the existing data. We followed geologists on their tours up and down the East Coast and across the Upper Glades. We took a trip from Fort Myers to Pompano with a survey party. We went on a probing expedition with soils technologists and finally traversed the glades with our imagination colored by that of the salesmen who sold these golden acres in the forty-eight states. Romance, fiction, tragedy, humor, some facts, much theory; but all contributed to a history that made this analysis of existing data one of the most interesting studies I have ever experienced.

Some of these records and reports have been most useful, others invaluable for the comparable data available at the time they were made. I wish here, too, to acknowledge the assistance of those who have cooperated with us during the past two years. Without the benefit of their experience, we could not have made the progress which we are able to report today.

From the soils surveys we now know, for the first time, where the soils are which have potential agricultural value. Likewise, we now know the location of areas which, because of soil type and depth are suitable only for water conservation. And, it appears to me, as it does to you, there are other areas that cannot be economically brought into production regardless of the soil type or soil depth.

From the geological surveys, we are learning something about the movements of underground waters. In an area composed of organic soils, a thorough knowledge of sub-surface hydrology is most important. It is imperative that we know the lands on which the water table cannot be mechanically controlled. The agricultural use of such lands should not be encouraged. Those who attempt agricultural use of these areas will de-

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* Engineer and Project Manager, Soil Conservation Service, U. S. Department of Agriculture in Arkansas, North Dakota, and Florida since 1935; in charge Everglades Project since 1938. Formerly Mining Engineer (1920-26) and Contracting and Construction Engineer (1926-35) with experience in bridge and highway building and in the design and installation of municipal water and sewer systems.

mand water concessions that will likely upset the control of water on the more valuable neighboring lands.

The potable qualities of the surface waters are being determined by taking samples at different locations in the Everglades at different seasons of the year. Chemical analyses are made of these samples and from the results of these analyses we may determine the probable source of the water; that is, whether or not it traveled underground to reach a selected location. There are indications that the surface waters in certain areas may not be potable at all seasons of the year, even for cattle. The results of these analyses of surface waters will also furnish much basic information on the hydraulic and hydrologic characteristics of the area.

We will, within a few days, start the dyking of several sections for recording the water table in an enclosed section as compared with the water table in adjacent open areas having free water movement. At the same time, surplus water from a section in agricultural use will be discharged into the adjoining section and the water table in the reservoir section recorded. After a few years, we may reverse the movement of this water so that we can find out what effect this rotation practice will have on crop yields, insect control, and water table control.

Additional hydraulic data, however, are needed to supplement the survey and research data before we can develop water-control plans for soil and water conservation. The water-control facilities which were constructed 25 or 30 years ago have been neglected and now they are operating at less than 10 percent efficiency for relieving flood waters on cultivated lands. The planting of fall crops is delayed in the Okeechobee area because 90 percent of the canal capacity is utilized at that time of the year in draining the uncultivated portion of the Everglades.

From May 1, 1940, to May 1, 1941, approximately 4,075,000 acre-feet of water was discharged into the Atlantic Ocean by the drainage canals. Of this amount, 175,000 acre-feet was let into the canals from Lake Okeechobee. A total of 3,900,000 acre-feet then was drained from Everglades lands. This amount represents about two acre-feet from each acre of peat and muck lands in the Everglades. What portion of this 3,900,000 acre-feet is represented by surface runoff from the uncultivated glades? How much was contributed by underground seepage? Where along the course of the canals did most of this inflow occur? What can be done to increase the efficiency of the canals for the benefit of the cultivated areas? These are some of the questions that can be answered only by the collection of hydraulic data to supplement the geologic, engineering, and soils surveys.

An examination of the contour map will show the effects of draining the uncultivated glades. What was originally a canal 80 feet in width, extending from the Lake to Lock No. 2 near Port Everglades is now a valley from four to six miles in width with the canal in the center of the valley. Probably 90 percent of the more serious soil burning in the Everglades has occurred in this broad valley created by the drainage effects of the North New River Canal.

To collect hydraulic data, it has been necessary to install water-investigation controls. These controls have been located in the broad valley adjacent to the North New River Canal. The importance of collecting these hydraulic data will best be appreciated when the time comes to finance the repair and maintenance of present water-control facilities and

new construction designed to provide more adequate water control on cultivated lands. I am old-fashioned enough to suspect that whoever supplies the funds for such construction will want to examine the hydraulic data offered in support of the water-control plans.

The Congressional Act which authorized the expenditure of Federal funds by the Soil Conservation Service in the Everglades region of Florida. restricted the expenditure of these funds to that amount expended by Florida state agencies for like activities. State agencies were therefore requested to cooperate in installing water-controls for hydraulic investigations.

For a more comprehensive hydrological study, these water-investigation controls need to be expanded to include other areas in the Everglades. Such expansion appears to be of first importance if we are to collect sufficient hydraulic data to support an over-all water control plan for the conservation of soil and water. The construction of a North and South dike between the Hillsboro and North New River Canals on Range Line 40-E would impound rainwaters in the uncultivated glades and make possible the collection of much needed hydraulic and hydrological data. Incidentally, the construction of this dike would permit the control of surface waters on two townships of desirable agricultural lands east of the proposed dike alignment.

The repair of the spoil bank on the Hillsboro Canal would impound surface waters in an area of more than 300 square miles and would prevent this area from becoming a fire hazard. Until these water controls are installed and hydrological observations are made, we can determine neither the maximum water table for this area nor the influence which a controlled water table will have on adjacent agricultural lands.

In addition to the pertinent data collected from representative or critical areas. these water-investigation controls make a direct and immediate contribution toward fire prevention and soil and water conservation. By the retention of surface waters in the uncultivated glades, the canals will also have greater capacity to relieve flood waters in the upper reaches of the canals. These surveys and studies are being conducted with project personnel and are financed entirely with Federal funds. We are dependent. however, upon state agencies' cooperation in installing water-investigation controls.

There is need for more adequate water control on cultivated lands. When we stop to consider the loss in land elevation that has occurred during the past 25 years, only simple arithmetic is needed to calculate the time when rock excavation will be necessary for lateral ditches on cultivated lands. Then what? From the Everglades Experiment station, we learn that below the plow sole, soil subsidence is in direct proportion to the depth at which the water table is maintained. About one-half inch loss in elevation each year can be expected under the most favorable water table compatible with crop yields. The most favorable water table does not exist on large scale farming operations. What then can be done to approach a balance between the loss in elevation by increasing crop residue on the land? These are some of the questions that are being discussed by soils technologists.

Water control is becoming more difficult on lands that require annual tillage. This is particularly true on lands that have been in use during

the past 15 to 20 years. Cost of farming operations will probably be increased because of the decreased permeability of the surface soil. As this condition becomes more apparent, mole drains will likely become less operative, resulting in surface waters standing longer on the fields. Continued use of these agricultural lands will then require a change in method of soil management and/or type of crop.

The advantage that will be taken of the land use classifications; the extent to which agricultural adjustments will be made to conform with factual data; the progress that will be made toward the develoment, installation, and operation of an over-all plan of water control, are questions that only the land owners and operators in the Everglades can answer. I am much encouraged over the progress that has been made thus far.

THE PRINCIPAL ELEMENTS OF A LONG TIME SOIL AND WATER CONSERVATION PLAN FOR THE EVERGLADES

H. A. Bestor*

To discuss the present day problems of the Florida Everglades from the viewpoint of its future, and looking forward to a long time agricultural use of the land and the conservation of all its physical resources, it is essential to take into account the activities which are responsible for the present condition of reclamation and occupation of the area.

This paper attempts to visualize briefly the reclamation activities to date, to point out some of the principal elements which must be given sympathetic consideration for the future, and to indicate the economic potentialities of these Everglades lands which justify such consideration.

That much has been accomplished by drainage of the Everglades to date is evident from the fact that a considerable portion of the area, formerly under bondage of inundation and accessible only by boats, is now transversed by railroads, highways and communication lines, and is interspersed by numerous agricultural communities and projects.

This transition, however, has consumed many tedious years of effort, which apparently has been more political than technical minded, since all through the various steps of development there is evidence of indefinite appreciation or evasion of fundamental facts as regards long range protection of resources under a progressive unit plan of development necessary to completely satisfy certain vital, physical requirements of the area.

Florida really began "wishful thinking" about its Everglades nearly a century ago (1845) when the State Legislature first requested its United States Senator to press upon the Federal authorities the importance of a survey with the view of reclaiming this great area.

This initial interest culminated in a federal investigation and finally in the United States Government transferring these Federal lands, under the Swamp and Overflowed Lands Grant Act of 1850, to the State of Florida, which, in turn, placed them by the Legislative Act of 1855, under the supervision of a Board of Trustees of an Internal Improvement Fund irrevocably for the purpose of agricultural reclamation and development.

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* Drainage Engineer, U. S. Sugar Corporation, Clewiston, Florida, since 1928; also Acting Chief Engineer for the South Florida Conservancy District, Pahokee Drainage District, Pelican Lake Sub-Drainage District and South Shore Drainage District, and Engineer for special investigations of flood control and drainage projects in the Everglades Drainage District. Formerly connected with B. J. Arnold Engineering Company, Chicago, Illinois, and Ford, Bacon, and Davis, New York, on irrigation developments in Montana, Colorado, and Wyoming, and with the United Fruit Company in Central and South America; Resident Engineer (1924-26) George B. Hills Engineering Company, Jacksonville, Florida, in charge flood control investigations for Caloosahatchee Improvement District; Engineer-in-Charge (1926-28) investigations for navigation and flood control Caloosahatchee River and Lake Okeechobee drainage areas for U. S. District Engineer, War Department, Jacksonville and New Orleans.

For many years the State, under the authority of the Internal Improvement Board, employed every means having a complexion of reclamation, such as grants of land to railroads and land companies, to encourage the development and use of the land. This failed in reclaiming lands, for the most part, and involved the area in much complicated litigation.

The Legislature of 1905 enacted drainage laws and created a State Board of Drainage Commissioners, which provided more direct objectives for reclamation. Through the years that followed, much other legislation was enacted and numerous investigations were made, largely in the interest of drainage, and work was intermittently performed by State forces and under contracts with private companies, as money permitted through the sale of State lands. However, in 1913 the Legislature confirmed the creation of the Everglades Drainage District, defined its boundaries, established a Board of Commissioners, and authorized the powers to levy taxes on the land within the district, to borrow money, and to issue bonds for the construction of reclamation facilities.

The historical background is probably familiar to all who are concerned about the Everglades, and particularly to those who are interested in its reclamation. However, the highlights of reclamation activities are reviewed briefly as they have had so much influence on the situation which exists today.

The engineering investigations made during 1906-1908 by the United States Department of Agriculture, at the solicitation of the Trustees of the Internal Improvement Fund, were supervised by Mr. J. O. Wright and directed by Mr. C. G. Elliott of the Bureau of Drainage Investigations. This report, submitted June 25, 1909, confirmed the feasibility of Everglades reclamation, ratified the work performed by the State, and proposed a Plan of Drainage involving the control of Lake Okeechobee and a scheme of diagonal arterial canals. This represents the foundation of the plan followed in the subsequent activities of the Everglades Drainage District.

Following this study and report there has been continued legislative activity and numerous investigations have been made in accordance with widely varying public questions that have been raised in connection with the development of the area.

In 1913 the Board of Commissioners of the Everglades Drainage District and the Trustees of the Internal Improvement Fund employed a Florida Everglades Engineering Commission. Its report, dated as of October 19, 1913, is commonly known as the "Isham Randolph Plan." It generally confirmed the Wright plan and the feasibility of the Everglades project, provided the impetus for the district to embark on its program of reclamation, and encouraged the subsequent development of sub-drainage districts.

The September hurricanes of 1926 and 1928 did considerable damage to reclamation facilities then constructed, interrupted agricultural activities, and placed the entire area in financial difficulties.

Subsequent to the 1926 storm the Federal Congress authorized the U. S. Engineers, War Department, to examine the Caloosahatchee River and Lake Okeechobee drainage areas with a viewpoint of flood control and navigation. This investigation resulted in the creation, by the Florida Legislature, of the Okeechobee Flood Control District to cooperate with the

Federal authorities in safeguarding the Everglades from such storm hazards as were experienced in the Okeechobee region at that time.

Following this storm the Board of Commissioners of the Everglades Drainage District also employed an Everglades Engineering Board of Review to pass on the engineering features of Everglades drainage, with the view of refinancing the project. This report, as of May 3, 1927, confirmed the feasibility of reclamation, suggested changes in the Randolph Plan and recommended progressive unit development for the future.

As a result of the 1928 hurricane, Congress authorized a review survey of the Caloosahatchee River and Lake Okeechobee drainage areas, and later authorized the appropriation of funds to construct Lake Okeechobee Flood Control works, which included control canals connecting the Lake with the Atlantic Ocean and the Gulf of Mexico, thus providing a cross-state navigation channel. This federal construction, commenced about 1930, was completed in 1935 at a cost of more than twenty million dollars.

Lake Okeechobee's regulation and maintenance operations are now under the jurisdiction of the United States Engineers. Lake surface is planned for control between elevations of 14.0 and 17.0 feet above mean sea level with outlets by locks, to the east and west, to permit cross-state navigation.

Due to the further damage of facilities during the 1928 storm and the general situation prevailing at the time, the Everglades Drainage District could not obtain relief in financing, so no action was taken on the then current investigations and reports. Thus the District was unable to continue its program of construction or to maintain or operate its existing reclamation facilities. Except for administrative functions and litigation with its bond holders, the affairs of the District have been practically dormant since that time.

Briefly reviewing this background of history, it is found that, by 1920, water had been generally lowered in the Everglades as a result of the drainage activities of previous years, but that lands had not been reclaimed to such an extent as to permit of consistent agricultural use. Even after 1920, with the active development of sub-drainage districts, the agricultural use of the land was more or less spasmodic due to circumstances of flood effects and the insufficiency of reclamation operations, and particularly to the damage suffered by sub-district facilities during the storms of 1926 and 1928.

The activities of the United States Engineers subsequent to 1928 in building levees and control works to regulate the waters of Lake Okeechobee inspired confidence in further agricultural activities to the extent that various sub-drainage districts were able to refinance and rehabilitate their reclamation facilities. Since 1930, land developments throughout the 'Glades have expanded rapidly, and the past ten years represent the only really consistent agricultural use of Everglades lands during the involved history of the area.

At present, practically all land developments within organized sub-drainage districts are paying returns on their investment. This successful use of the land, since 1930, is creditable to the improvement of sub-district plans of development with pumping plants, combined with the fact that, for the first time in the history of the Everglades, drainage conditions have

been materially assisted by consistently low lake levels and the further circumstance that there has been no occurrences of extreme storms. During the past ten years the distribution of rainfall also has been fairly favorable.

Present day agricultural activities in the Everglades have developed so rapidly that their importance is scarcely realized. It is desirable to mention some of these activities, as they are so fully indicative of the proven possibilities of the area, and because their permanence and security in the future are so inextricably dependent on careful long range planning and management with respect to soil and water resources.

Present successful agricultural operations are scattered over the Everglades, but are largely confined to the Lake region and along the Atlantic coastal areas. The University of Florida has two agricultural Experimental Stations, one on the typical sawgrass peat near Belle Glade, and the other in the lower margin of the 'Glades near Homestead. The United States Department of Agriculture has a Sugar Cane Breeding Station at Canal Point, and the State Prison Board has an agricultural farm near Belle Glade. Besides these agencies there are a number of private agricultural research and experimental operations.

In general, there are more than 100,000 acres of reclaimed land in vegetables and unusual crops, some of which have previously been imported from other countries. It is reputed that these agricultural activities are accountable for commodities inbound and outgoing equal to two railroad cars of freight per acre.

In addition to this general farming, a large sugar cane project has been organized in the Upper Glades. This development commenced about 1928, and has had an exceptionally successful operation, indicative of the tremendous potentialities of the area for sugar. There are now some 30,000 acres in cultivation, averaging about 35 tons of cane which produces about four tons of sugar per acre and about five gallons of blackstrap molasses per ton of cane. The largest sugar house in the Continental United States is located at Clewiston with a capacity for grinding more than 6,000 tons of cane per day through a season extending from October to May.

There are also about 1,100 acres of lemon grass in the Clewiston area, principally harvested during the summer, with a successful distilling and dehydrating plant where the oil is extracted and the "spent grass" is dried and mixed with locally available molasses for cattle feed.

The State of Florida ranks with the two top open range cattle producing states. Many of these cattle are being grazed in the Everglades because the area has proven values in grasses and feeding.

Altogether, these agricultural developments only scratch the surface of the real potentialities of the Everglades. Visualizing these activities in terms of revenues to communities, and counties, to the State and to the nation, even the most skeptical should have little doubt that there is full justification for the reclamation which has brought all this into being, and which will permit an expansion and development in keeping with the economic demand for the crops which this section of the State can produce.

However, this apparently successful agricultural use of the Everglades is exacting a tremendous toll from the natural resources of the area, due especially to neglect of proper water conservation measures which could

and should protect those soil moisture relationships that are so vital to a permanent use of organic lands of this nature.

Peat and muck soils of the type characteristically found in the Everglades, being comparatively low in silt, clay and other mineral constituents, are highly combustible when dry. Even when exposed to normal conditions of cultivation they are peculiarly susceptible to natural oxidation resulting from the normal chemical and microbiological processes that are very active in materials of this nature. The natural ground surface of such land is thus subjected to loss of elevation when drained, due to compaction and oxidation, and may even become quite impervious to water at the surface as these processes continue. Consequently, unless judicious water table relationships are maintained, these losses may become very severe and the soil itself may even become too dry for the successful growth of most crops.

Comparisons of original elevations twenty years ago with general elevations of today indicate a surface loss of about three feet, and within the areas of sub-drainage districts conditions have reached the point where some of the reclamation facilities will soon have to be revised to meet the physical requirements of water movement. This may occur in some instances even before the bonded indebtedness is satisfied on the existing reclamation facilities.

The economic justification of reclamation lies in the ability of the lands to produce. There is no known reclamation project where the physical relations of water supply are as favorable, where the advantages of water use are as great, where its manipulation costs are as reasonable as in the Everglades, or where there is less available use and more abuse of its resources. Operations and maintenance are often deferred in well qualified areas through lack of funds or because of other objections to paying the cost of such service, although production per acre would readily offset the necessary expense.

Much of the general farming is done at the present time by speculative land tenants, who consider the winter months a normal agricultural season, although there are many ways in which the land can be properly used throughout the entire year. Often soil is "wasted" by promiscuous dyking and ditching in preparation for a temporary crop, without consideration for the succeeding or permanent use of the land. Comparatively speaking, it is rare to find property permanently occupied by farm homes or improvements. Consequently, burning and other soil abuses occur on unattended areas which are not conducive to conservation, and which threaten the long-range, agricultural use of land.

Attention to good practice in regulating water by sub-districts, and the interest of farmers in the intense use of their properties with uniform soil moisture control, is the only method which can protect the presently developed areas and provide a long range use of the land. Continued disregard for such principles will soon bring about many disappointments in the present day results.

From a more general viewpoint of these relationships over the entire Everglades, it appears that the predominant interest has been to release surface waters from all areas as rapidly as possible in order to enable the land to be reclaimed at will wherever land developers desired, simply by the expedient of gravity influence with laterals extending into the land

from the main arterial drainage canals. This objective accounts for much of the difficulty which reclamation of the Everglades has experienced not only through its early development but right on down to the present time.

Land ownership and interest in development are now scattered all over the 'Glades, and lands have been taxed almost regardless of the degree of benefit received or their ultimate potential use. The Trustees of the Internal Improvement Fund, as owners of State lands, have freely disposed of lands as a source of revenue rather than with any very definite appreciation of their physical qualifications for reclamation.

As Mr. Mayo has so well said at the opening of this conference, it would have been fortunate if the Everglades project could have been commenced on a more definite basis of progressive development, with specific areas planned to coordinate with the physical relations of the entire project, so that reclamation could have been expanded in accord with sound economic demand for the agricultural use of land. This consideration must still be given the area in future planning if we expect to conserve the resources of the unreclaimed lands in the Everglades and protect the present developments.

The zealousness of the past has finally accomplished, in a way, the drainage of the 'Glades. In fact, the insidious loss of water through the years has virtually overdrained much of the area to a disconcerting extent. The coastal settlements, which are dependent on the back country seepage for their water supplies, are already complaining about lack of water, and large areas of idle peat and muck land have been seriously burned and the soils have generally subsided. These effects are as serious as the soil erosion problems of other states, and neglect of the Everglades is more pertinent, as these conservation losses are occurring during the formative years of agricultural development or even before agricultural use has been made of the land.

Thus the over-emphasis that has been placed on drainage has resulted in loss of soil water until, under present day reclamation, there is persistent negligence in controlling this important resource, both for the agricultural use of the land, and for the conservation of undeveloped or idle areas.

The principal elements working against the conservation of Everglades' resources appears to be the neglect of those in authority to recognize its real needs and, on the basis of those needs, to establish a sufficiency of reclamation plans for the guidance and protection of land users. Thus there is a very great need for more definite regulations to insure a property owner that his lands are under a plan of reclamation which will meet all physical requirements or which will permit him to cope with the water situations in his particular area. So long as reclamation development is left to haphazard independent solution, confusion will continue to jeopardize the security of property.

It is now generally agreed that our Everglades reclamation activities need attention. Of recent years considerable land along arterial canals has been developed by individual owners rather than by organized subdrainage units. This random selection of land and the promiscuous dyking and ditching of small tracts is wasteful of land and cannot consistently meet physical requirements without ultimate interference with the needs of other tracts. It is questionable, furthermore, if such accumulation of

drainage waters as is developing on this unplanned basis can be handled by existing arterial canals.

Such indiscriminate drainage, the lack of centralized authority and interest of the State, the dormancy of the Everglades Drainage District in maintaining and operating its facilities and general financial conditions, combined with the overdrainage of the area, causing a shortage of water supply for the East Coast communities and permitting several severe muck fires in the Everglades, has developed real concern regarding the question of water management.

It is commonly thought desirable that the large areas of idle lands should be restored, as nearly as possible, to their original condition of inundation in order to control fires and encourage wild growth and normal soil building processes again. There are varying opinions, however, as to how this could be accomplished, and there are surprising differences of opinion as to how the manipulation of water might be accomplished so as to conserve the organic soils of the Everglades.

There have been many public meetings for the discussion of the reclamation and conservation problems of the Everglades during the past few years, contributed to by various local, county, state and federal agencies, and there have been several investigations and reports on various phases of these problems. However, none of these discussions has resulted in any very specific recommendations as to what should be done.

The most recent activity was initiated by the City of Miami and other Lower East Coast Communities through concern in their municipal water supplies. The National Resources Committee of Washington, D. C., was approached, resulting in organizing the Southeastern Florida Joint Resources Investigation as a cooperative activity of the State Planning Board, the U. S. Department of Agriculture, Soil Conservation Service, the U. S. Department of the Interior Geological Survey, the U. S. Engineers-War Department and various State and local agencies. In connection with this, a Peninsular Florida Basin Committee was created consisting of ten state and ten local representatives appointed by the Governor of Florida to act as a coordinating and advisory committee for the investigation.

The U. S. Engineers have been active since about 1930 on the Federal lake control project and have made rather comprehensive hydrological studies of the Kissimmee river watershed in its relation to the problems of regulating the waters of Lake Okeechobee.

The U. S. Geological Survey and the Soil Conservation Service commenced investigations late in 1939 with federal funds matched with those from State and local sources such as the Everglades Fire Control Board, the University of Florida, Dade County and municipalities within the County. These Federal agencies are presently employed, and much valuable technical information has been and is being obtained.

This work is commendable since investigation of the geological formations and underground waters of the Everglades, the measurement of surface water and stream flow, the classification and mapping of soils and the accumulation of meterological and hydrological records are of vast importance. But the detailed examination of the Everglades for such technical information alone will not provide a comprehensive picture of the involved problems or permit of conclusions on which to recommend a definite plan of reclamation and conservation.

SUMMARY

The early efforts of the Trustees of the Internal Improvement Fund to encourage land use through grants of land to railroads, land companies and other alleged developers, involved the Everglades in a confusion of land ownership and interests not conducive to best reclamation activities. This situation resulted in the creation of a Board of Drainage Commissioners and more direct attempts on the part of the Trustees to construct reclamation facilities with what funds were available from any sources of revenue such as the sale of lands, and finally in the creation of the Everglades Drainage District with authority for levying a direct tax on the lands.

The history of this period emphasizes distinct phases in the attempts at reclamation and in public questions that arose in connection with it such as the feasibility of reclamation, the value or permanency of organic lands for agricultural use if drained, and the sufficiency and permanence of works in progress.

To quiet public opinion during these specific periods, the Trustees of the Internal Improvement Fund and authorized officials of the State of Florida employed engineers to investigate the various situations and report on the practicability of work performed, the feasibility of reclamation, and to make recommendations for the continuance of the program.

It is noteworthy that all these engineering examinations recommended that the reclamation of the Everglades is physically practical, but neglected to point out the vital need for intelligent water management to conserve its sensitive organic soils, to emphasize the importance of progressive unit development, or to suggest definite, comprehensive plans which would coordinate the physical requirements of specific areas with the entire project.

The outstanding investigations made at critical stages of development were as follows:

1. The examination and report made under the direction of C. G. Elliott, Chief of Drainage Investigations, U. S. Department of Agriculture during 1906-1908 called the J. O. Wright Plan, supported the State expenditures under the Internal Improvement Fund and suggested the present system of diagonal arterial canals.

2. The report of the Florida Everglades Engineering Commission during 1913, called the Randolph Plan, has directed the activities of the Everglades Drainage District since that time and supported its financing by direct land tax and the issuance of bonds for the performance of work.

3. The report of the Everglades Engineering Board of Review in 1927 was used by the Everglades Drainage District to justify the necessity of refinancing and its continuation of work. Circumstances of the "depression period" prevented action on this report and the District's development and maintenance program has remained dormant since that date.

4. The Legislature created the Okeechobee Flood Control District to cooperate with the subsequent activities of the U. S. Engineers' War Department in the construction of engineering works to regulate the waters of Lake Okeechobee, and thus prevent the recurrence of such tragedies as accompanied the 1926 and 1928 hurricanes in that region.

The persistence of drainage operations in the Everglades through these phases, the activities of sub-drainage districts and the control of overflow from Lake Okeechobee by the U. S. Engineers has finally resulted in the present agricultural use of land and the developments we have today. However, the lack of definite plan and active authority to pass on the engineering sufficiency of the work and to control the processes of water management are creating serious confusion. Present activities are exacting a tremendous toll of the natural resources of the Everglades, and until these conditions are recognized and steps are taken to correct them, these irretrievable losses will continue.

The permanence of these sensitive, organic soils and the duration of our present agricultural development are being challenged, the huge investments in land improvements and sub-district reclamation facilities are being threatened, and the large areas of wild lands and certain municipal water supplies are being jeopardized by the lack of a comprehensive plan of water control and management in this area.

The proven agricultural value of Everglades soils under proper conditions of management, combined with the real possibilities for protective water control, makes the existing wasteful effects of economic concern to local interests, to the State of Florida, and to the Nation as a whole.

Reclamation plans must consider all economic factors such as selecting the most favorable areas to permit of successful occupation and use of the land, but the fundamental problem of the Everglades lies in the correct handling and consistent control of its waters. Rainfall and flood flow are no respectors of the quality of the land the water must pass over except as the soil itself affects water movement. There are highland water sheds and flood effects, outside of the main overflow area leading directly from Lake Okeechobee. Therefore, water control is a general as well as a specific problem. The lack of appreciation of the value of water to soil management and the present neglect in the regulation of water should provide real public concern as to the long time use of our Everglades soils.

The present agricultural practices and the inadequate control of soil moisture within developed reclamation projects is probably more harmful than the neglect of the large areas of unused lands.

Present agricultural activities are unconsciously exploiting the organic soils of the Everglades, and conservation of resources by reclamation processes is not presently recognized; by the laws of the State; by the administrations of sub-drainage districts; and, consequently, by individual developers or land owners.

The haphazard formation of sub-drainage district areas, the indiscriminate development of individual areas, and the promiscuous dyking and ditching of small tracts, is wasteful of land and deterimental to water control without interference between interests and it is questionable that arterial canals can be made to accommodate such confused water situations.

The Everglades never before has presented such great need for a general engineering check-up. Present situations are far more important now, with substantial developments and pertinent demand for conservation of resources, than on the previous occasions which influenced the Trustees of the Internal Improvement Fund and the Everglades Drainage District to invite investigations. It appears particularly essential at this time to

analyze the new situations in the light of present day experiences and more complete physical knowledge.

There are no insurmountable obstacles which would prevent a solution for the Everglades problems. Relations of physical requirements are largely fundamental. and there is abundant evidence of effects, so that engineering interpretation of facts should be relatively simple, and questions of ownership and occupation of land is only a matter of public and state acceptance of plans for their own protection and betterment.

There is a wealth of existing physical and technical data available for analyses without making further extensive field investigations. Therefore, it is considered that with sufficient public interest, qualified hydraulic engineers of undoubted integrity and national reputation could determine the problems and recommend the procedure to establish a long range control plan for the Everglades within a reasonable period of time and cost.

RECOMMENDATION

It is recommended that the Florida Soil Science Society present the importance of protecting the Everglades from the existing wasteful abuses of its resources to the Honorable Spessard L. Holland. Governor of Florida, to the Trustees of the Internal Improvement Fund. and to the Board of Commissioners of the Everglades Drainage District, requesting that they give consideration to the employment of an outstanding engineer and commission to investigate the present problems of the Everglades by analyzing the present status of land ownership. all organization and engineering facts, conditions in contributory water sheds, existing reclamation facilities, the relations of Lake Okeechobee control and of the Everglades Drainage District and its sub-drainage districts and other occupation of land, all with a view of determining the problems of the Everglades drainage areas so as to recommend the immediate steps to be taken to curb the present waste of land, to protect present ill-advised developments, and to prepare a definite Everglades plan for the reclamation and conservation of the soil and water resources of this great area.

B. THE ECONOMIC PHASE

INTRODUCTION

R. K. Lewis,* *Chairman*

Shortly after lunch today I was informed that the Honorable J. Mark Wilcox would be unable to attend and that I would be called upon to substitute for him. I think most of you know our good friend Mark. He is a man of considerable ability and so you can well appreciate what a difficult task I have on my hands in endeavoring to substitute for him. I am forced to speak extemporaneously because I do not have the benefit of any data which appears in my files.

As most of you know the Everglades Drainage District is a district which embraces some four and one half million acres of land. It includes all, or a portion of, eleven counties, as portrayed on the maps of Figures 1 and 2, presented by Mr. Beardsley on pages 108 and 109.

In order to lead up to the discussions by speakers who will follow I shall endeavor to briefly relate the history of the Everglades Drainage District, the tax problems and the chaotic condition which confronted the landowners at the time the 1941 settlement was consummated. Details of the bond refunding plan and the tax settlement will be covered by the other gentlemen who follow me.

As mentioned by Mr. Wallis this morning, this district is a political subdivision of the State of Florida created by the Legislature in 1913 to drain and reclaim the Everglades area. To finance the excavation of canals and other works in creating a drainage system successive bond issues were floated from about 1917 to 1925. To support these bonds the Legislature imposed heavy annual acreage taxes, or special assessments upon the lands within the district. These acreage taxes were theoretically levied in proportion to benefits conferred upon them by the works of the district. All lands were classified for tax purposes in six zones, each zone having a fixed annual tax graduated from 3 cents to $1.50 per acre.

Not long after the passage of the 1925 Act levying these taxes, the boom broke and construction under the plan of reclamation came to an end. For lack of taxes the district soon ceased to function as a going concern. Along about this time additional bonds were authorized to the tune of some twenty millions of dollars, as I recall. Fortunately Mr. Mayo, the Commissioner of Agriculture, sitting here, refused to sign these bonds and so we were not saddled with that debt. (Applause.)

On January 1, 1931, the district defaulted on its bonds and thereafter became hopelessly insolvent. Conditions grew progressively worse. People were unable to pay their taxes. By 1940 the situation was virtually hope-

* West Palm Beach Attorney and former member Florida Legislature. Born in Palm Beach County with a life-long interest in the Everglades, Mr. Lewis has been active in all phases of programs resulting in readjustment of indebtedness for the Everglades Drainage District and the Pahokee and Pelican Lake Sub-Drainage Districts.

less. The district indebtedness was seventeen million dollars, most of it long past due. Ninety-five per cent of the land was delinquent in its taxes for about ten years. The bondholders, by a writ of mandamus, had secured a tax spread on the 1940 roll for more than fifteen million dollars. Furthermore, by law practically every landowner's title had been forfeited to the district for nonpayment of taxes.

On the day after default occurred in 1931 Mr. H. C. Rorick, of Toledo, Ohio, organized a bondholders' protective committee and succeeded in getting eighty-nine percent of the bonds deposited with his committee. From then on Mr. Rorick harassed the board of commissioners of the district and the landowners no end.

His committee brought and fomented many suits against the district in an effort to enforce payment of their delinquent bonds and coupons and to coerce the board into selling off the forfeited lands to produce funds with which to discharge these obligations. Finally, in 1940, the committee prosecuted test foreclosure suits to foreclose its bonds against the forfeited lands of large individual landowners.

During all of these years the Everglades Board made a number of unsuccessful attempts to refinance the district and compromise its outstanding indebtedness. Successive legislatures enacted laws designed to afford relief to the landowners by reducing the annual special assessments and compromising delinquent taxes. Each such law, however, was stricken down by the courts at the instance of the bondholders' protective committee upon the ground that the same were an unconstitutional invasion of the contractual rights of the bondholders. Out of these rulings came the writ of mandamus imposing the heavy spread previously mentioned.

With this state of affairs the landowners became thoroughly alarmed in 1940. Landowners' committees were organized throughout the district. These committees worked closely with the Everglades Board.

Finally a broad plan of refinancing was conceived. It contemplated compromising the total district debt upon a greatly reduced basis by the employment of a proposed loan from Reconstruction Finance Corporation. This loan was to be secured by refunding bonds which were to be supported by a revised tax structure drastically reducing the annual taxes and extending landowners the privilege of compromising the accumulated delinquent taxes at a ridiculously low figure.

A low tax compromise program was considered most expedient to encourage the redemption of title, restore confidence and assure the ultimate success of the program.

Before such plan could be consummated it had to be authorized by appropriate legislative enactment. At the outset this appeared to be an almost hopeless task because of the failure of previous attempts to accomplish the same end. (About 1937 the Board had secured a commitment from R.F.C. which was too low to interest the bondholders.)

In June, 1940, representatives of landowners and the Board initiated negotiations with the bondholders' committee and R.F.C. Because of the complexity of the situation these negotiations were protracted. Men working on the deal spent months in Washington. An attractive committment was secured from R.F.C. but no deal was made with the bondholders' committee until Governor Holland took over and drove a bargain.

The climax in consummating the plan is an interesting story. Shortly

after Governor Holland was inaugurated, in 1941, a number of the landowners went to see him and requested his active assistance. Fortunately Governor Holland, as is his custom, went right into the matter. He showed a keen grasp of the problem and expressed a desire to help.

As soon as he fully understood it he promised folks he would do something about it. From then on things began to happen fast. Within sixty days from the time Governor Holland took over he had a deal with the bondholders, necessary legislation was passed and the whole refinancing program was assured of success.

Thus in sixty days Governor Holland closed a deal upon which others had spent ten years trying to accomplish. I shall never forget the meeting held in Thomasville, Georgia, in March, 1941, at which time the bondholders' protective committee, representative land owners, the Governor and his cabinet held a conference.

Mind you the meeting took place in another State. By necessity it had to take place in Thomasville because members of the bondholders' committee were afraid to come into Florida for fear they would be served with process in litigation down here. Governor Holland did not stand back on his dignity—he went to Thomasville with the desire of accomplishing something. Significally he told Mr. Rorick this:

> *"Now, Mr. Rorick, it would seem that for some ten years you have been negotiating with one hand and litigating with the other, and I want that dual type of negotiation to end here and now—I'm a fellow who wants to either negotiate or litigate, but I'm not going to do both at the same time. Let's get together. If you don't want to negotiate, we'll litigate 'till hell freezes over."*

This approach did not take long to bring the bondholders around. Next day they came into Florida to negotiate—where they were served with process (laughter).

A few words about the deal. An agreement was reached with Reconstruction Finance Corporation, the bondholders' protective committee, who had control of the bonded debt, and the largest common creditors representing more than sixty-six and two-thirds per cent of the debt of that class. Under it R.F.C. agreed to lend $5,660,000.00 to enable the district to compromise its debts and refinance. The bondholders protective committee agreed to sell its bonds and coupons through a group of interim bankers acting as a dummy for R.F.C. at approximately fifty-six per cent of the fact amount of their bonds with all matured unpaid coupons attached. The Trustees of the Internal Improvement Fund agreed to write off their common claim of approximately $1,100,000.00 for a cancellation of its taxes. Arundel Corporation, of Baltimore, agreed to sell its common claim through interim bankers to R.F.C. for twenty-five per cent of the principal.

With control of the claims of all classes against the district vested in R.F.C., a program of composition was to be filed in the District Bankruptcy Court. Upon consummation the obligations of the district would be scaled down from $17,000,000.00 to approximately $5,660,000.00.

The legislative enabling act for the program, although far from perfect, represented a great accomplishment. The scope of its relief exceeded the

fondest expectations of everyone. It was comprehensive, completely rezoning the district, and revising its existing tax structure. It must have been a good bill, acceptable to everyone, because it was passed unanimously by both houses of the Legislature within an hour after its introduction.

I am happy to report that the whole deal has been consummated. The bonds were acquired by R.F.C., bankruptcy proceedings were instituted by the district and the tax compromise plan was put into effect. I have a feeling that this refunding marks the beginning of a new era for the Everglades. It will undoubtedly contribute much to its growth and progress. It will redound to the benefit of all of us. For instance, I see in this meeting a real estate man who made $30,000.00 in commission on the sale of land which he could not have made otherwise.

This, taken together with the work which will undoubtedly flow from the studies which are now in progress by you gentlemen, should mean a great deal to this section of Florida.

I have seen the Everglades and traversed it ever since I was a kid, but sitting here listening to these experts today I have learned more about the physical aspects of this great area than I have ever known before.

I have heartily enjoyed every single address which these men have made. We are fortunate to have them here to give us the benefit of the time and study they have devoted to the various physical characteristics of the Everglades area and its manifold soil, water and conservation problems. Great benefit will result from their studies I am sure. It is now by pleasure to introduce Mr. J. E. Beardsley who will discuss the present status of plans for refinancing the Everglades Drainage District.

PRESENT STATUS OF PLANS FOR REFINANCING THE EVERGLADES DRAINAGE DISTRICT

J. E. Beardsley*

Mr. Lewis has covered the past history of the negotiations conducted from time to time looking toward a refunding of the Everglades Drainage debt. He has touched upon a great many details in a limited time, but still very lightly. He hasn't told you of the three separate and distinct trips to Washington in an effort to convince the Reconstruction Finance Corporation that it should assist the District in refunding its debt. He hasn't told you about other efforts, that some of you are familiar with from press reports, the Stifel-Nicolaud and Exselsen and other plans proposed by individuals and other agencies toward a refunding. Before I go any further with the discussion of the present status of the plan now being consummated for the refunding of the District debts, I would like to see the hands of the actual property owners who are present. (About half of those present in audience of approximately 150 people held up their hands.) This shows a very encouraging interest on the part of the people of the Everglades. You people are interested in what we are now doing in the way of tax collections and in the way of reduction of past due delinquent taxes, and also in the way of future administration of taxes and of the Board, because we all know very well it is more than theory which might apply equally well to some place in the Mississippi Valley.

Mr. Lewis has mentioned the part of Governor Holland in the negotiation which led to the passage of the 1941 legislation which is this Bible. (Copy of 1941 Act.) It is no less. When I call it a Bible, I do not speak a sacrilege. Because the 1941 Act is more than an operating agency under which the taxes on your land are being collected and disbursed, there are several features of the Act that ought to be touched upon.

Probably the principal item is the liquidation of the amount of delinquent taxes. Mr. Lewis has mentioned the astronomical levy which was imposed by the Legislature and put on the books in 1940 in the sum of more than Fifteen million dollars, representing seven years at the 1925 rate, which was two and a quarter million dollars for the District. The 1941 Act operated to compromise those figures.

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* An Everglades Farmer since 1914 on the south shore of Lake Okeechobee at Ritta and a Commissioner of the Everglades Drainage District since 1934; elected General Manager of the District in April, 1942. In the pioneer days of Everglades development Mr. Beardsley represented his community in various drainage meetings and conferences of the Everglades Good Roads League. Subsequently (1933) he was appointed Co-receiver of the Disston Island Drainage District; also Co-receiver and later, Supervisor, of the Clewiston Drainage District; also, Supervisor, Sugarland Drainage District. At the present time he is serving as a farmer member of the State Agricultural Planning Committee; as a member of the State Defense Council and Chairman of the Sugar Products Division of its Agricultural Committee; as Chairman of the Agricultural and Food Supply Committee of the Hendry County Defense Council; as a member of the Advisory Committee for the Everglades Project of the Soil Conservation Service, U. S. Department of Agriculture; and as a member of the Soil and Water Conservation Committee of the Soil Science Society of Florida since the founding of the Society in 1939.

You might be interested to know Mr. Wallis has definite figures, but I estimate the average delinquency in 1941 on Everglades land was eleven years. On zone one lands around the Lake, and in some parts of the East Coast, this amounted to twenty dollars an acre. Under the compromise feature of the 1941 Act, there was offered two bases of settlement. One for those taxpayers delinquent for 1936 and prior years; and another for those delinquent subsequent to 1936. So that it became the simplest possible method available for paying back taxes. Another feature which must not be lost sight of was the method of arriving, under the 1941 Act, at the present levy of six hundred and thirty-two thousand dollars. If you will compare that with two and a quarter million you will find a reduction of seventy per cent in actual tax levy on the District.

It is true that the better class of lands in the District are paying the same levy as under the 1925 Act, most excessive of any time in the history of the District.

The zonal relationships are shown on a lay-out of maps which I borrowed from Mr. Wallis. Figure 1 represents the 1925 Act and Figure 2 the Acts of 1941. If you will compare the No. 1 and No. 2 zones adjacent to Lake Okeechobee you will note the tremendous change which has been made in what we hope will prove a realistic basis of taxation. There are other areas in Dade County where please notice particularly the No. 2 zone as compared with the extent of the No. 5. The No. 2 zone has the $1.10 rate and you will note it does not cover nearly so much area as in 1925. The No. 5 zone has the 30c rate. The refunding tax structure is detailed in Table 1.

Those of you who have traveled Highway 26 down through the Glades will recognize the area at the junction of 26 with the Miami Canal. Perhaps some of you feel that some day that land will be fit for cattle, when planted with grass, but certainly it cannot be regarded as an economically productive area at this time, hence it is in the 10c zone.

It was on the basis of the 1941 Act that the Board prepared tax schedules to make zoning as realistic as possible. Now the Board recognizes that there were a number of probable—I started to say palpable - errors.

People say there is citrus planted on 40 acres—put it in zone one, but there is nothing on the land adjacent to it, so it ought to be put in zone six to be paid at ten cents.

Nobody has yet undertaken to be that realistic about zoning the lands in the Everglades. The 1941 map contains knowledge which the Board attempted to follow in what now appears has been a reasonable estimate of taxation on productive acreage, or productive use, as illustrated by study of the maps in view here today.

In speaking of the 1941 Act I have touched on two things, primarily, one being the matter of compromise taxes. Let me make it clear again to those of you who have taxes delinquent for 1936 or prior years that those taxes may be paid at the rate of their present zoning times two. In other words, to liquidate those taxes it is only necessary to pay twice the rate for the zone as now scheduled. For those who have lands delinquent for 1937, 1938, 1939 and 1940 it will be necessary to pay for one year only to compromise your delinquent taxes; one year at the new rate, whatever that may be for the zone in which your land lies.

TABLE 1.—Refunding Tax Structure of the Everglades Drainage District as Provided by the Legislative Acts of 1941.

(Prepared by W. Turner Wallis, June 10, 1941)

County	Tax Zones								School Lands	Exempt Lands	Total
	1	2	3	4	5	6	7	8			
	ACREAGE										
Highlands	——	——	——	——	——	12,800	70,522	——	1,920	——	85,242
Glades	7,252	2,400	——	——	5,800	36,614	235,895	——	3,853	——	291,814
Hendry	4,724	4,480	——	1,920	——	40,055	316,414	44,954	9,460	——	422,007
Collier	——	——	——	——	——	——	——	202,541	7,680	136,402*	346,623
Monroe	——	——	——	——	——	——	——	——	——	115,200*	115,200
Okeechobee	——	——	——	——	——	13,612	66,718	——	640	——	80,970
St. Lucie	——	——	——	——	——	——	67,564	——	1,917	——	69,481
Martin	1,226	1,195	——	1,280	4,800	20,261	169,521	——	5,117	——	203,400
Palm Beach	64,023	57,661	72,773	70,944	111,537	402,278	246,246	——	29,682	1,423	1,056,567
Broward	2,080	11,409	——	36,110	28,169	340,741	268,832	——	13,554	3,904	704,799
Dade	12,676	5,618	——	15,229	80,945	62,316	328,023	——	20,480	{ 84,025	
										{491,217*	1,100,529
Total	91,981	82,763	72,773	125,483	231,251	928,677	1,769,735	247,495	94,303	832,171	4,476,632

*Note: Lands embraced in Everglades National Park.

TABLE 1.- Refunding Tax Structure of the Everglades Drainage District as Provided by the Legislative Acts of 1941 *Continued.*
(Prepared by W. Turner Wallis, June 10, 1941)

County	Tax Zones 1	2	3	4	5	6	7	8	Total
TAX LEVIES									
Rate per Acre	$1.50	$1.10	$ .90	$ .80	$ .30	$ .10	$ .03	$ .0125	
Highlands	$ —	$ —	$ —	$ —	$ —	$ 1,280	$ 2,116	$ —	$ 3,396
Glades	10,878	2,640	—	—	1,740	3,661	7,077	—	25,996
Hendry	7,086	4,928	—	1,536	—	4,005	9,492	562	27,610
Collier	—	—	—	—	—	—	—	2,532	2,532
Monroe	—	—	—	—	—	—	—	—	—
Okeechobee	—	—	—	—	—	1,361	2,002	—	3,363
St. Lucie	—	—	—	—	—	—	2,027	—	2,027
Martin	1,839	1,314	—	1,024	1,440	2,026	5,086	—	12,729
Palm Beach	96,035	63,427	65,496	56,755	33,461	40,228	7,387	—	362,789
Broward	3,120	12,550	—	28,888	8,451	31,074	8,065	—	95,148
Dade	19,014	6,180	—	12,183	24,283	6,232	9,841	—	77,733
Total	$137,972	$91,039	$65,496	$100,386	$69,375	$92,868	$53,093	$ 3,094	$613,323**
PERCENT OF TOTAL DISTRICT TAXES									
Highlands	—%	—%	—%	—%	—%	2%	.3%	—%	.5%
Glades	1.8	.4	—	—	.3	.6	1.2	—	4.3
Henry	1.2	.8	—	.2	—	.6	1.6	.1	4.5
Collier	—	—	—	—	—	—	—	.4	.4
Monroe	—	—	—	—	—	—	—	—	—
Okeechobee	—	—	—	—	—	.2	.3	—	.5
St. Lucie	—	—	—	—	—	—	.3	—	.3
Martin	.3	.2	—	.2	.2	.3	.8	—	2.0
Palm Beach	15.7	10.3	10.7	9.3	5.4	6.6	1.2	—	59.2
Broward	.5	2.1	—	4.7	1.4	5.6	1.3	—	15.6
Dade	3.1	1.0	—	2.0	4.0	1.0	1.6	—	12.7
Total	22.6%	14.8%	10.7%	16.4%	11.3%	15.1%	8.6%	.5%	100.0%

**Note: Excluding lands embraced in Everglades National Park.

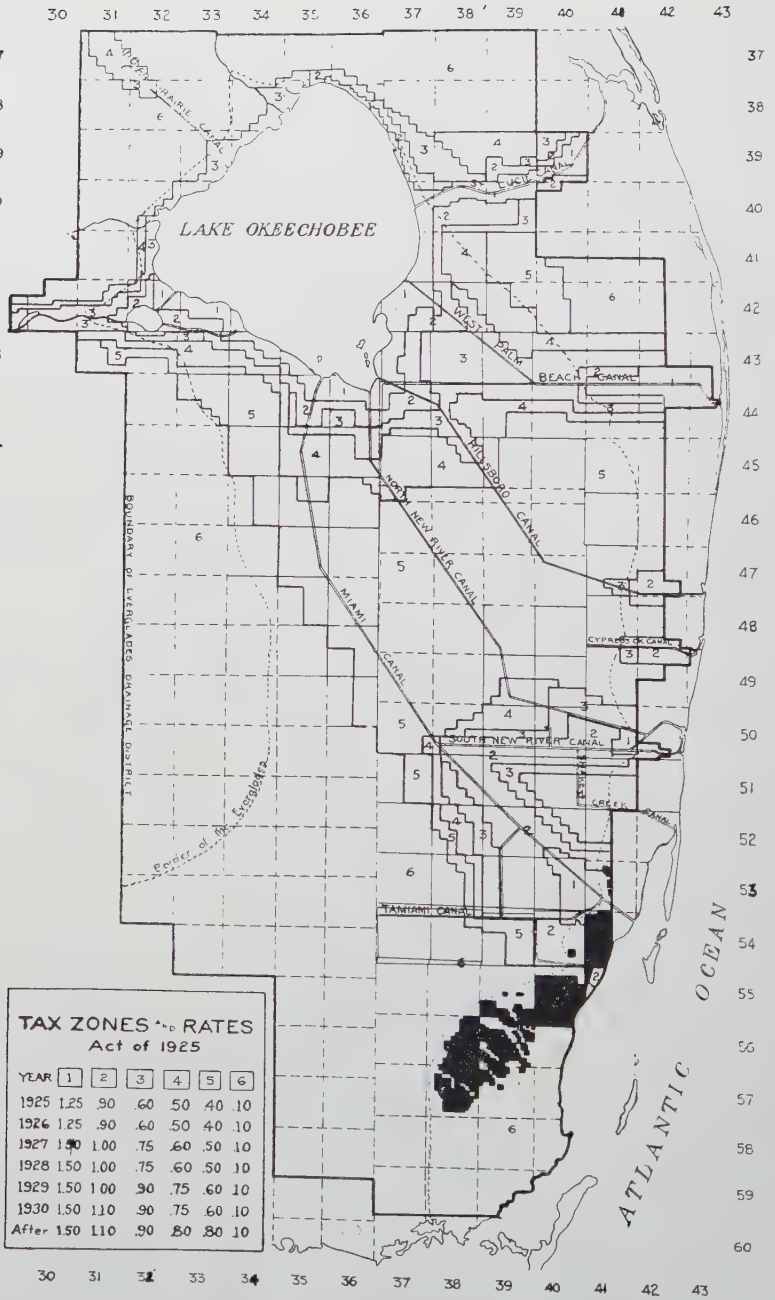

Figure 1.—Tax Zones and Rates, Everglades Drainage District, Act of 1925. Areas in black are exempt. Report of the Chief Drainage Engineer, 1925-1926, Tallahassee, Florida.

Figure 2.—Revised Tax Zones and Rates, Everglades Drainage District, Acts of 1941.

I know some land. in the Caloosahatchee area formerly scheduled at a dollar and a half an acre. which under the 1941 Act is now in the ten cent zone; the realistic part about this taxation is liens can be decreased from twenty dollar per acre to twenty cents. Some of these figures may seem extreme, but before I close I will be happy to tell you how this happens.

There is a further important feature of the 1941 Act and that is authorization for the Board to proceed toward a refunding. It has to be done legally and with the approval of the Legislature.

Here is a booklet which is a supplement—which I will call the "New testament" regarding our plan with R.F.C. for refunding. Copies of either this or the 1941 Act are available by writing the District Office in Miami.

Before leaving the 1941 Act I want to pay tribute to the assistance rendered by others than Governor Holland—and I doubt if the taxpayers of the District. or the people whose interests lie in the Everglades or in these East Coast towns which are the means of ingress and egress to the District—will ever fully appreciate what Governor Holland has accomplished by taking hold of this problem with his customary vigor and insight. This is apparent from the fact that we had already failed three times to negotiate a loan with the R.F.C.; today we are in the process of closing one. Primarily Governor Holland is responsible.

In closing, however, I would be remiss if I did not pay tribute to certain other men and the organizations which made their services available, notably Mr. R. K. Lewis, and Mr. W. Turner Wallis, the one an attorney and the other an engineer, both of the Brown Company; Mr. Raymond Alley, an attorney for Bessemer Properties, Inc.; and Mr. W. G. Troxler and Mr. Luther B. Mershon, of counsel for the U. S. Sugar Corporation, all of whom were of inestimable assistance in the preparation of this necessary legislation. And, if it does not sound as if I were going out of my way to pay tribute, I might also say we would never have arrived at the preparation and passage of this Act if it were not for the assistance of these men and especially that of Mr. M. Lewis Hall who worked indefatigably with the Board as its attorney.

Now you may want to know why I have discussed the 1941 Act and the relation of taxes, and the fact that the new rates are realistic. Where do we stand today? As a member of the Board and after 28 years of experience in the Glades perhaps I am supposed to know something of land and taxes out there. However, as the saying goes, familiarity sometimes breeds contempt. At any rate, I was asked last summer by counsel for R.F.C. to talk about compromise taxes. As to collection of the delinquent taxes, what do you think the Board will realize from collection of delinquent taxes in two years? I said seven hundred and fifty thousand dollars. How much in the first year? Five Hundred thousand dollars—and that is from a District which has a notably poor record of tax payment. Investigation indicated clearly that the District had collected less than fifty thousand dollars a year, during the period it has been doing business since default in 1931. On that basis, to tell R.F.C. you could get $500,000 dollars sounded like shooting at the moon.

I would like to say tax clerks have collected and remitted to the Treasurer of the Board four hundred and thirty thousand dollars to date,

of compromised taxes. That is not in a year, but since the first of September, because the numerous suits against the Board had not been dismissed until the end of August. Thus, since the first of September we have received four hundred and thirty thousand dollars in compromise taxes and we still have four or five months to run for a full year.

In addition there have been collected two hundred and thirteen thousand dollars of 1941 taxes. Sounds like a small amount on a levy of six hundred and thirty-two thousand, but I see several farmers in this group and they know that no farmer expends part of his working capital during the winter months for taxes. He needs that operating capital and keeps it moving into more crops. No matter how much the pressure for payment of taxes, the average Everglades farmer is not going to come in until June when he winds up his season, to pay his taxes. While I may be oversanguine or optimistic about the future, I still believe there will be another hundred thousand dollars in 1941 taxes and another hundred thousand dollars in compromise taxes paid in before the first of July.

What are we going to do with it? We have already sent to R.F.C. five hundred and fifty thousand dollars, to be remitted by it to the Broward Bank and Trust Company, as disbursing agents.

We have made a list of small claims, Class II, amounting to forty-two thousand dollars net, to be liquidated at 26.14 on the dollar. Bonds amounting to nine million three hundred eighty thousand dollars will be liquidated at 56.918—say 57 cents. There is also a principal claim amounting to one million eight hundred thousand dollars, due a dredging outfit, which was purchased by the Interim Bankers at 20 cents on the dollar. Governor Holland approved this and the fact that twenty-six cents on the dollar will be paid on this claim, a difference of one hundred and twelve thousand dollars, which is the amount the liquidating agents will get for handling this entire deal. The District could also have bought that claim for twenty cents on the dollar, if they had had the four hundred thousand dollars to buy it with. These people bought it and are legitimately entitled to the fee. I might say that is the only "gravy" that appeared in the Everglades Refinancing operation. I might say there is also an item of fifty thousand dollars which was set up as fees for negotiating these claims and refunding expenses.

I should like to say that there has been a liquidation of seventeen million dollars in bonds and coupons alone, and a class two obligation of one million and eight hundred thousand dollars to a dredging corporation not including interest and also to the Internal Improvement Fund the sum of one million and ten thousand dollars on tax certificates, and Class II claims to various individuals and corporations of one hundred and sixty-five thousand dollars. We have wiped out delinquent taxes in a sum closely approaching twenty-five million and all of that has been done at the expense to taxpayers of fifty thousand dollars. So I'm ready at any time to defend the work of the Board.

As a matter of fact I will be glad to show any critics that care to come to me at any time that this Board has gotten out with the least expense of any refinancing program that I know of, not only in Florida, but anywhere in the South. Today we are at the point of being refinanced. Mr. Hall, our attorney, phoned this morning from New Orleans in the hopes

he would arrive in time for the meeting, but was unable to make it. He has been before the Court there in connection with the refinancing.

We have sent $550,000 to Broward Bank and Trust Company through R.F.C. and it is ready to pay all unsecured claims. There is also the sum of three hundred and seventy thousand dollars in acreage taxes on hand and enough administration taxes to enable the Board to get along a while.

With regard to maintenance, let me say to folks who know the Everglades that we did need a maintenance feature in the 1941 Act. We would like to have at least seventy-five thousand dollars annually for this purpose. When Ernie Graham and Uncle Joe Peeples, who is now out of the picture, heard there was a maintenance item contemplated, they really hit the roof. Because of such opposition in the Legislature, this was dropped, since the primary purpose was to secure passage of a refunding Act. We hope to go back in 1943 and ask for authority for one hundred and thirty-five or one hundred and forty thousand dollars for necessary maintenance work in the District, for the ensuing two years.

THE INTERRELATIONSHIP OF PHYSICAL AND ECONOMIC FACTORS IN EVERGLADES RECLAMATION

W. Turner Wallis*

During one of the several discussions regarding the program for today's meeting it was jokingly suggested that, as I had drawn the last assignment, it would be left for me to give the solution to the problems affecting the conservation and development of the natural resources of the Everglades.

At that moment and later as I considered what to say to make the best possible contribution to this discussion in the time alloted, it seemed utterly preposterous for any one person to presume to know all the answers involved in the solution of these problems. However, the thought prompted by that casual remark became sufficiently fixed in my mind until I finally wound up talking to myself, which many of you will admit is a not too uncommon result of Everglades thinking.

Although I didn't succeed in convincing myself that I even knew, much less should disclose the detailed solution at this time, I did satisfy myself that the solution consists of the determination and adoption by a centralized and legally constituted authority of an over-all plan and fixed policy for the conservation and development of the land and water resources of the Everglades.

While past accomplishments and experience afford a present knowledge of the things which have not contributed to the best interest of the area, everything that has been done contains some value, if no more than as an object lesson that should serve to prevent a future repetition of past mistakes.

If there had been no start towards the reclamation of the Everglades and today we were considering the principal elements of a sound land-use program, the major factors in order of importance would be the character and depth of soils and underlying formations, surface elevations and geographical location.

Under existing conditions the size and type of ownership, present transportation and water control facilities, overlapping taxation and inequalities of assessment, future rate of expansion, maintenance of facilities and the means of financing required additional work are further factors to be considered in the determination of a sound and equitable plan.

Before discussing the above additional factors influencing future plans, it seems desirable at this point to answer the possible questions in your minds as to whether there have been previous plans? If so, were they both sound and adequate, and why didn't they afford a solution of the

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problems, particularly in view of my previous statement that a solution of existing problems would follow the adoption of an over-all policy and plan.

A careful and impartial study of previous reports relating to the Everglades will convince anyone that at no time during the period since 1913 has there been a lack of sound recommendations to guide the program of Everglades reclamation.

However, no reflection on previous plans, based on the more meager data and information then available, is implied or intended by the confident assertion that present knowledge of the area if fully assembled and properly analized, will enable revised plans to afford better guidance for the future. A more general appreciation for the importance of conservation, replacing a former predominant interest in exploitation, and a better understanding of the complex nature of the problems will assist towards public support for the necessary program to accomplish the desired results.

While it is now comparatively easy to point out where things should have been done differently, it is more important to determine the underlying cause for such actions, if a repetition of past mistakes is to be prevented. A good illustration of this is afforded by the past failure to be guided by the following recommendation, quoted from the report of the Florida Everglades Engineering Commission, dated October 25, 1913:

PROGRESSIVE DRAINAGE

> "We have encountered an idea, which if not generally prevailing is, at least, entertained by a large number of intelligent citizens of Florida to the effect that the problem of draining the Everglades can not be solved by progressive steps, but that the whole area must forthwith be covered by a great interdependent system of canals. We believe this to be an erroneous idea, and that the Everglades can be reclaimed progressively as is now planned by your Board: that the work can so proceed as to reclaim the lands only as fast as there is need for those areas as homesteads and food producers."

The extent of partial reclamation of lands throughout the entire area, far beyond any present or probable future need for these lands as homesteads or food producers, is beyond question the biggest single factor involved in a solution of most of the existing problems.

Senate Document No. 89, 62nd Congress, 1st. Session, relating to the Everglades, furnishes fifteen thousand reasons for this condition by the single statement that sales of Everglades lands by the Trustees of the Internal Improvement Fund and other owners had increased the number of individual owners of lands in the Everglades from about a dozen owners in 1909 to upward of 15,000 on July 1, 1911.

Doubtles each of the 15,000 owners, all of whom paid far more for their land in advance of any reclamation than most of it is worth today, believed in principle that the only sound policy was one of progressive drainage, provided, however, his land was to be among the first to be drained.

While that same condition exists today, we now know far better than in 1911 what lands are most suitable for reclamation, and in what areas the required facilities can be provided to the best advantage and at the

lowest cost. However, a solution of this problem is not as simple a matter as the mere indication on a map of certain areas to be reclaimed in a designated order, with other areas and their owners condemned for all time to the payment of taxes with no prospect of ever being able to use their lands.

Although the majority of owners of present undeveloped areas would unquestionably abandon their lands, if convinced they were unsuited for reclamation or profitable use, for those areas where only a deferred order of reclamation was indicated because of location with respect to existing or proposed facilities, there is every reason to expect pressure for reclamation of whatever needless thousands of acres might be required to serve their individual interest, regardless of the consequences to the interests of others, or of the area as a whole.

The best promise for a solution of this problem would be the adoption by the State of a policy under which the owners of lands located in a deferred area could trade for State lands within areas to be next in line for reclamation and successful use.

The completion of State Road No. 26 and other improved transportation facilities, the favorable adjustment of the debt problem of Everglades Drainage District, the establishment and growth of new agricultural activities, the development and speculative interest in Everglades lands born of war conditions have all contributed to an accelerated rate of land improvement and use, and to a correspondingly increased critical condition confronting these lands from the added burden to be imposed on existing inadequate drainage facilities.

While these newer lands, as well as lands previously in use that alone were more certain of adequate service from existing facilities, will be under the constant threat of losses that in one season would pay their full share of the required additional facilities, this work is only practical if undertaken and regulated by some central authority.

Without exception the greatest burden placed on the existing canals constructed by Everglades Drainage District and their chief cause of failure to serve occupied lands is the flood discharge from unused lands, which suffer increased subsidence and added fire menace by the uncontrolled runoff of seasonal rainfall.

In the development of the future over-all plan the first step is a determination of the respective development and conservation areas based on soil factors, followed by the design of a system of transportation and water control facilities for the required service of each such area. In this connection the order of priority for development will be determined largely by the existence of present facilities which can be most cheaply expanded for adequate service.

Everglades lands are subject to county and special disrict taxation on an ad valorem basis and to taxation by Everglades Drainage District and various sub-drainage districts on a benefit basis, with the latter determined by either legislative act or court decree.

The wide variance of ad valorem tax rates caused by the erratic overlap of special taxing districts is well illustrated by Palm Beach County where for a recent year there were forty-one different rates within Everglades Drainage District, with a variance as great as 68 per cent for immediately adjacent tracts of land.

Although little, if anything, can be done to correct this condition affecting the burden of ad valorem taxation, a large measure of relief could be afforded if the individual county tax assessors would predicate their valuations for Everglades lands on the results of the studies completed and underway by the Soil Conservation Service and other Federal agencies, and upon the use classification of the lands embodied in the future over-all plan for the area.

The most convincing proof of the disproportionate burden of drainage taxes to actual benefits is afforded by the extent to which larger scale operations have been transferred in recent years from the areas embraced within sub-drainage districts and the higher tax zones of Everglades Drainage District. In many instances the frying pan to fire aspects of these changes will become more apparent as reclamation for additional lands is attempted without the benefit of a coordinated plan of water control.

While a large measure of tax relief has been afforded by the adjustment and refunding of outstanding indebtedness, there is widespread opportunity for further improvement of conditions from a program of rehabilitation and redesign of existing main and sub-drainage facilities. Debt reduction and increased use of the land will contribute to make the necessary funds available without an increase in taxes, and in many instances a resultant increase could be more easily paid than present rates without the benefit of adequate protection.

With present water control facilities generally inadequate for the service of lands now in use, it necessarily follows that the future rate of expansion in use of lands will require a corresponding improvement and extension of required facilities. The past stagnation of Everglades Drainage District, the assistance of the Federal Government in the construction of the levee for the cotnrol of Lake Okeechobee, and the value as canals of the borrow ditches resulting from the construction of State and county roads have all contributed to a somewhat general acceptance that whatever future work might be required should, or would have to be done without cost to the lands to be benefited.

For any development of the Everglades area roads are a first essential, and their construction from state and county funds is fully justified by the taxable values thereby created and by the service rendered local interests as well as the general public. Consideration of water control needs in the design and location of future roads is the best and most certain means of obtaining these facilities at the lowest possible cost.

The foregoing more obvious problems of the Area are illustrative of their close interdependence and of the necessity for an over-all plan to afford a sound basis for their solution.

In conclusion I wish to emphasize that the benefits of planning for the conservation and development of the land and water resources of the Everglades will be in direct proportion to the extent and consideration given all related problems and to the breadth of vision of those responsible for the final plan. While the foundation of any worthwhile plan is a fixed policy—in this case one of conservation and sound development—planning itself must be a continuous process to properly meet the needs of changing conditions.

GENERAL DISCUSSION

CHAIRMAN LEWIS: The meeting is now open for questions or comments from the floor.

MR. JOHN S. PETERS, South Miami: I would like to know whether or not it would be practical for an individual farmer to divide a section of land and use part of it as a reservoir with the idea of pumping water into the reservoir section during rainy periods and have it there for use during dry periods.

CHAIRMAN LEWIS: Are you referring to your own section of land, or do you want to store water on somebody else's land? If the latter, I think a proper approach would be to take it up with the Everglades District Board to secure a permit from them.

MR. PETERS: It would be stored on my own land, if practical from an engineering standpoint.

CHAIRMAN LEWIS: I'll call upon Mr. Wallis to answer that.

MR. TURNER WALLIS, West Palm Beach: I was afraid of that; I am the only one whose name he knows. Other speakers are better qualified: certainly other engineers who are familiar with the land. Too many factors enter into that. The natural, underlying formation might make it impossible to retain water for a period until you want to use it. Some others should volunteer their views on the subject. Mr. Davis, what do you think?

MR. KAY DAVIS, Soil Conservation Service, Ft. Lauderdale: I think as Mr. Wallis has said, it would depend to a very great extent upon the porosity of the rock underneath the soil, because if it happens to be a Miami oolite formation, as discussed by Mr. Parker, it would be impossible to hold water in an enclosed area of this type and size for any appreciable time. However, if the underlying rock is comparatively hard or impervious, then it may be possible to retain a high water level in the reservoir section for an appreciable period. Size of reservoir and pumping costs must be given serious consideration in a project of this nature. Such a study is being started near the Hillsboro canal in the deep Everglades peat of the Upper Glades that Mr. Evans told you about this morning. We propose to pump the water from a full section in agricultural use onto an adjoining reservoir section. But that study is just getting started. We are hoping to get some worthwhile results from the standpoint of insect control as well as the handling and storage of water. We also propose to see if such water table as may be maintained in the reservoir section may have some influence on air temperatures.

In your case, Mr. Peters, before you attempt to hold water in a reservoir section of this nature you should first ascertain the character of the rock underlying the soil, because if it is porous, water could not be held in such a reservoir very long. On the basis of our present knowledge we would be very reluctant to recommend such a proposition as a practical operation. However, if you should try such an arrangement we would be very glad to know what results you obtain.

Chairman Lewis: We would like to continue this discussion, but the time is getting along and there is still a business meeting to be held. Mr. Mayo, do you have anything further for us before we close.

Commissioner Mayo: Friends, I just want to say I have thoroughly enjoyed this discussion today. In fact, it has proven the most interesting meeting of its kind I have ever attended, and I will be most happy to take back reports to Governor Holland and other members of the cabinet. As mentioned this morning the State is the largest land owner in the Everglades and should be greatly concerned over the conservation problems out there that you have discussed so fully. Something must be done and again I say we shall be deeply grateful for any constructive suggestions or recommendations or definite plans for development that may come out of this meeting.

Chairman Lewis: Is there any further discussion? Is there anyone else who would like to be heard? If there isn't, I will now turn the meeting back to Dr. Neller.

Doctor Neller: Thank you, Mr. Lewis, for the fine way in which you have helped with the program and the splendid part you have taken in it on such exceedingly short notice. I am sure I speak the sentiments of all present when I tell you that we are grateful to you for this assistance. We shall now turn to the brief business meeting of the Society that is scheduled at this time and for which all are welcome to remain.

BUSINESS MEETING, SOIL SCIENCE SOCIETY OF FLORIDA

President Neller Presiding

Chairman Neller: Ladies and Gentlemen, I am sure we all feel that this discussion of Everglades problems today, unusually complete though it has been, still leaves a most important job to be done. Reference is particularly to the recommendations or plans of action that Mr. Mayo has very definitely called for and of which, I am confident, we all have a very conscious feeling of need. I am wondering, for instance, if it might not be a good thing for the Society to develop some carefully prepared resolutions which might not only recognize certain jobs that already have been well done but also point the way to things that need to be done for these Everglades of ours that we prize so highly. I am sure we are all agreed that much has been done which is good and constructive, such as the fine manner in which the bonded indebtedness of the Everglades Drainage District has been refinanced. But that is not enough, for if we do not take better physical care of the Everglades and provide it with a better pattern of reclamation which will bring adequate relief from the pressing conservation problems that were reviewed in some detail earlier in the day, the future of this great area is not at all bright. In other words it will represent a march right on down grade towards the time when the tax structure of the district, of which we have heard so much, shall have to be fully dismantled and laid to some sort of final rest for actual lack of physical substance in the land to support it. More briefly, if we do not take better care of the Everglades we will not have anything at some future time either to farm or to tax.

The obvious need is a sufficiently comprehensive plan of water control to dispose of really excess or storm waters but which will still develop and maintain water reserves adequate for all requirements of the present and of the future. This, of course, is a problem that is becoming more pressing with each passing month, as was pointed out repeatedly in the course of the conference.

The Chair will be glad to entertain any remarks or suggestions whether in the way of committees to be formed or resolutions to be drawn.

Mr. W. Turner Wallis, West Palm Beach: I received an entirely undeserved compliment from Mr. Beardsley and Mr. Lewis, but before that I had in mind to request the preparation of a resolution addressed to various Federal agencies who have been active in recent studies with the view of expressing the appreciation of the Society for the work of these agencies as such. In such a resolution I would like most particularly to have the loyalty and efficiency of the individuals directly responsible for the conduct of these studies fully emphasized.

I move that the Resolution Committee prepare such a resolution.

Chairman Neller: It is moved and seconded that such a resolution be drawn, and I now ask the Secretary to advise the Resolution Committee to this effect.

Mr. Wallis: The resolution should be addressed to the various agencies active in the Everglades studies under way expressing the appreciation of the Soil Science Society of Florida for the fine work they are doing, but most particularly for the loyalty and quality of the work of those immediately in charge, as individuals. (Reported p. 123)

Chairman Neller: It has been moved and seconded that such a resolution be drawn. In view of the fact that Mr. W. F. Therkildson, who is Chairman of the Standing Committee on Resolutions, will not be in the city until this evening, I will ask Mr. Wallis to act as Chairman of such a committee to be made up additionally of Mr. Mossbarger, Mr. Lewis, and Mr. Beardsley.

Is there anything else?

Mr. H. I. Mossbarger: I am sure that this entire group joins me in expressing appreciation to each and every man who has contributed here today and that we all feel that the work they and others are doing, who are active in this field, should be continued. It is much too valuable to let any part of it be stopped. If any of it is discontinued for any reason, we would certainly be losing ground and going backwards instead of forwards. I have been particularly impressed here today with the character and quality of the talent that has been made available to tell us this story and the way it has been put together. In fact, I have been looking forward for several years to the time when it might be possible to get exactly this kind of information laid out in an understanding manner before the people who are most vitally concerned with the Everglades. I am particularly impressed with the earnestness and concern of agencies outside the State in these problems. Their enthusiasm and desire to do a good job and to reach the goal that we are all striving for in this work is tremendously commendable and is deserving of our every support.

I might make a comparison of this work with my glasses. When I

go to read, I can't see without them, but if I put them on they are the means of evaluation and of seeing what the problem is that we must develop if we are to get anywhere. The more extensive and thorough the basic data we have, the more carefully and permanently we can plan. In my opinion it would be a catastrophe to stop work of this nature.

So I wish to move, Mr. Chairman, that the Resolution Committee prepare a proper resolution acknowledging the great value of the work already done by State and Federal Agencies, in cooperation with local agencies, in surface and ground water studies and in soil and water conservation investigations. At the same time such a resolution should place the Soil Science Society of Florida unequivocally on record as supporting the continuation of this work.

CHAIRMAN NELLER: It is moved and seconded that this resolution be drawn along the lines suggested and the vote shows an unqualified approval. (Reported p. 125)

MR. R. K. LEWIS, West Palm Beach: In proposing that the Resolutions Committee draft an additional resolution, I want it to be understood that it embraces something concerning which I have first-hand knowledge. It is my desire that the committee draft a resolution of commendation and thanks to our Chief Executive, the Honorable Spessard L. Holland, expressing our appreciation for his leadership, his sympathetic attitude toward the refinancing of the Everglades Drainage District, and the passage of the necessary enabling legislation. In that connection I want to say that the people within the Everglades Drainage District—the landowners who have paid and are paying the taxes in the District—certainly owe Governor Holland a debt of eternal gratitude for the fine work he has done in handling the plans where so many others have failed.

I, therefore, move that such a resolution be addressed to Governor Holland.

CHAIRMAN: It is moved and seconded that such a resolution be drawn and from the heartiness of the approval I am sure there can be no question as to the real gratitude this Society feels for the great and good help Governor Holland has rendered South Florida in liquidating so large a part of an unfortunate and oppressive debt against the land of the Everglades Drainage District at one masterful stroke. (Reported p. 128)

MR. COLIN D. GUNN, Soil Conservation Service, Gainesville: In the course of the discussion this afternoon, unqualified tribute was paid to Governor Holland for his skillful and successful handling of the Everglades refinancing. However, it appears from this discussion, that a number of individuals and organizations also participated in and helped with this work in a very measurable way. Knowing the Governor as I do, I am confident that he would be among the first to give credit to his associates in such a task. In his behalf, therefore, and that of the Society in its own right, I move that a resolution be drawn commending certain landowners and other persons or groups for their invaluable assistance in refinancing the Everglades Drainage District.

CHAIRMAN NELLER: It has been moved and seconded that such a resolution be drawn. Are there any others to be heard from? (Reported p. 130)

MR. MOSSBARGER: I feel that we shouldn't overlook a very definite recommendation that was made in the course of Mr. Bestor's discussion this

morning. Reference is to the real emphasis he placed on the proper approach to the broader questions of Everglades reclamation, especially with regard to the need for a thorough and unbiased study of the whole problem and report by a competent commission. I, therefore, move either the formal adoption of the report by the Society with the recommendations it contains or that the Resolution Committee be instructed to prepare an appropriate acknowledgment of same with very definite emphasis on that section pertaining to the very great need for a comprehensive survey and analysis by a competent commission to be appointed by the Everglades Drainage Board with the approval of the Governor.

CHAIRMAN NELLER: This motion, in short, is that the Resolution Committee be instructed to draw up a resolution confirming and adopting the recommendations contained in Mr. Bestor's paper.

The motion has been seconded and with no dissenting vote is referred to the Resolutions Committee for attention. In the opinion of the Chair, the action suggested in this resolution comes about as near to making some of the definite recommendations that Mr. Mayo requested as anything that has been done. Accordingly, we shall make a very definite point of seeing to it that a personal copy of this resolution is sent to the Commissioner of Agriculture. (Reported p. 131)

If there is no one else to be heard from, perhaps we should have a report from the Secretary who has been quite busy around here today.

R. V. ALLISON: Mr. Chairman, the happy thing about an "Interim Meeting," as we call it, is that it doesn't give the Secretary-Treasurer much of anything to do, that is in the way of formal reports, since those will come at the time of our annual meeting in December.

You may be interested in learning that your official greeters at the door, Dr. W. T. Forsee and Mr. Len Jones, both of the Everglades Experiment Station, have chalked up a total for the day of 45 new members and of dues received from 48 old ones; also that a total of four sustaining memberships are already in hand by way of added assistance for the publication of what looks like quite a generous-sized proceedings that will grow out of this meeting. It is agreed by all that there will be a distinct advantage in having this record in a separate volume. Inasmuch as the annual dues of the Society is only one dollar, no lengthy explanation should be necessary for our real interest in sustaining memberships in this connection. The prospects for success in developing this category of membership in the Society should take on added brightness when you learn that Mrs. H. H. Wedgworth has very kindly agreed to take over this department for the Everglades Territory.

According to our attendance counts, about one hundred and fifty have been present during the day. This, of course, is very gratifying as is also the intense interest that has been displayed in all phases of the program. We are deeply grateful that Mr. Mayo could find it possible to be with us and I am sure you will all be happy to learn that he has honored the Society with his personal membership; also that he has requested ten copies of the Proceedings of the meeting just as soon as they are available.

There is one point that we would like to emphasize and that is the desirability of getting the fullest possible record of attendance. Please sign one of the attendance cards available at the door before you leave if you

have not already done so, whether you are a member or not, and indicate your interest with regard to the Proceedings. We stress this point since once the means are found to publish the report, the next important job is to get it into the hands of those who are really interested in our Everglades problems and who, furnithermore, want to do something about them. For my own part, I would much rather give a copy of the Proceedings of this meeting to someone who is interested in the problems it represents than sell one to another for any amount if he is not going to read it. That is why I am thrilled with Commissioner Mayo's request for ten copies, for his record as a public official has proven him to be a man who does not do much sitting around when there is important work to be done, especially if the interests of the State are involved as they most certainly are in the instance of the Everglades. Please do not hesitate to sign one of the cards, therefore, as we will be only too glad to send you a copy of the Proceedings if you care to have one, even though you may not care to become a member of the Society. Thank you.

CHAIRMAN NELLER: Thank you,Doctor Allison. Please remember, folks, that if conditions permit, the regular annual meeting of the Society for 1942 will be held in Gainesville next December.

Again we thank all who have helped so generously in making this Everglades meeting the real success it has been. I am sure we will all look forward to the published proceedings with a great deal of interest. To my way of thinking, the best tribute that has been paid to the meeting is to be found in the remarks of those who are already suggestiong the desirability of having another conference of this same type on the Everglades question some time next spring to measure the progress that has been made. I, for one, am very much in favor of it and am open to suggestions of any kind, from anyone at any time.

If there is nothing further to come before the meeting, I shall be glad to entertain a motion for adjournment.

Adjournment has been moved, seconded and carried and the meeting is so ordered.

RESOLUTIONS

A Resolution Pertaining to the Importance and Value of the Services Rendered by Governmental Agencies Active in the Joint Program for a Study of the Land and Water Resources of the Everglades Area.

Whereas, the accomplishments, findings and research programs of governmental agencies actively engaged in the study of the land and water resources of the Everglades Area have been presented and discussed at this conference called by the Soil Science Society of Florida in West Palm Beach on the 21st day of April, 1942; and

Whereas, a distinct contribution of immeasurable value towards a solution of the problems relating to the conservation and development of the natural resources of this Area has been made by the nature and scope of the work and investigations, completed or underway; and

Whereas, the able and interesting discussions of the various phases of this work by the representatives of each agency have assisted materially towards a better appreciation of the importance of an early solution of the related land and water resource problems of the Area; and

Whereas, the presentaion of each subject at this conference clearly reflects the ability and quality of services rendered by each participant.

Now, Therefore, Be It Resolved that appreciation be expresed by the Soil Science Society of Florida to the U. S. Geological Survey of the Department of the Interior and to the Soil Conservation Service of the U. S. Department of Agriculture and to the U. S. Engineers for the outstanding value of the joint program of study and research relating to the land and water resources of the Everglades Area; and

Be It Further Resolved that recognition and similar appreciation be expressed for the value and exceptional quality of the services of each individual actively engaged in this program; and

Be It Further Resolved that a copy of this resolution be sent to the Director of the U. S. Geological Survey of the Department of the Interior, Dr. W. C. Mendenhall; and to the Chief of the Soil Conservation Service of the U. S. Department of Agriculture, Dr. H. H. Bennett; and to the District Engineer of the U. S. War Department, Lieut. Col. A. G. Viney.

W. F. THERKILDSON, Chairman,
Resolution Committee,
Soil Science Society of Florida.

West Palm Beach, Florida
April 21, 1942

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON

Mr. R. V. Allison, Secretary-Treasurer,
The Soil Science Society of Florida,
College of Agriculture, Gainesville, Fla.

Dear Mr. Allison:

The two resolutions transmitted with your letter on May 30 not only manifest a keen appreciation of the value of surface- and ground-water investigations in the present and future economy of Florida, but also emphasize the advantage to be gained by coordination of activities of agencies engaged in exploring the land and water resources of the State. I note that copies of the resolutions were transmitted to the Board of County Commissioners of each of the eleven counties in the Everglades Drainage District.

Naturally I am pleased to know that undertakings of the Geological Survey, particularly those for which local interests provide part of the cost, are useful in serving present purposes. I am also pleased to know that those who have been in close touch with the cooperative undertakings realize the importance of continuing research and fact-finding long enough to determine in what manner the land and water resources of the State may be developed in order to yield the best over-all returns.

The recognition accorded the Geological Survey for its part in the land and water program being carried forward in southern Florida is most welcome. On behalf of the Survey, I wish to thank the Soil Science Society of Florida for its interest and support in the current and prospective investigational program.

Copies of the resolutions are being furnished Messrs. Ferguson and Parker.

Sincerely yours,

W. C. MENDENHALL,
Director.

A Resolution Pertaining to the Great Need for Continuing and Extending the Surface and Ground Water Investigations in South Florida.

Whereas, the fresh water resources of the State of Florida rank among her very greatest natural assets; and

Whereas, great importance is attached in any area to the most complete understanding possible of surface and ground water conditions, especially in relation to their rational conservation and use; and

Whereas, average values, covering at least 20-30 years of careful measurements and analysis, are absolutely necessary as a safe basis for any important calculations; and

Whereas, a knowledge of these relationships are of especial importance in an extensive, low-lying, flat country like South Florida both in relation to the conservation and use of the land and the growing requirements of domestic water supply; and

Whereas, only little more than an excellent start has been made in the study of these natural resources in South Florida as a result of work of the past few years and especially of the past two years by Federal, State and Local agencies; and

Whereas, there is grave danger that a good part of the work now in progress may have to be abandoned in the course of a very few months, because of the temporary nature of its support.

Now, Therefore, Be It Resolved that the Soil Science Society of Florida, in regular session in the course of an Interim meeting called in West Palm Beach on April 21, 1942, for the discussion of Everglades problems go on record as unconditionally recommending a continuation of the surface and ground water studies now under way in this general section, without any interruption whatsoever, and an extension of them if need be, through a sufficient period to afford unquestionable base values for use in the future; and

Be It Further Resolved that a copy of this resolution be sent to the Governor of the State of Florida, the Honorable Spessard L. Holland; and to the Commissioner of Agriculture, the Honorable Nathan Mayo; and to the Director of the U. S. Geological Survey of the Department of the Interior, Dr. W. C. Mendenhall; and to the Supervisor of the State Conservation Department, Mr. S. E. Rice; and to the Chief of the Soil Conservation Service of the U. S. Department of Agriculture, Dr. H. H. Bennett; and to the Chairman of the Board of Commissioners of Everglades Drainage District, Mr. Mark R. Tennant; and to the Chairman of the Everglades First Control Board, Mr. James A. Ball; and to the Director of the Florida Agricultural Experiment Stations and Provost for Agriculture of the University of Florida, Dr. Wilmon Newell; and each of the Chairmen of the Board of County Commissioners of the eleven counties located in whole or in part in the Everglades Drainage District.

W. F. Therkildson, *Chairman*
Resolution Committee,
Soil Science Society of Florida.

West Palm Beach, Florida
April 21, 1942

FLORIDA STATE BOARD OF CONSERVATION
S. E. Rice, *Supervisor*
FLORIDA GEOLOGICAL SURVEY
Herman Gunter, *Geologist*

OFFICE AND MUSEUM
Old Lower Dining Hall, F.S.C.W.

MAIL: DRAWER 631
Tallahassee, Florida

June 6, 1942

Dr. R. V. Allison,
Secretary-Treasurer
The Soil Science of Florida
University of Florida
Gainesville, Florida

Dear Dr. Allison:

Thank you very much for your letter of May 30, enclosing a copy of the resolution adopted by the Soil Science Society relating to a continuation of the surface and ground water investigations in South Florida, a copy of your letter to Mr. S. E. Rice, and copy of your letter to the Board of County Commissioners, Monroe County. I have read all of these with keen interest and I think that the resolution will serve a very useful purpose. I saw Mr. Rice Thursday and he seemed very much interested in the work of the Society as well as expressing the hope that the investigations could be continued.

Having some bearing on this you will be interested to know that we are increasing the amount alloted the cooperative work on both surface and ground water investigations with Mr. V. T. Stringfield, USGS, Washington, and Mr. G. E. Ferguson, USGS, Ocala, for the coming fiscal year. This investigation, however, is State wide and is not confined to the work in southern Florida.

Very sincerely yours,
Herman Gunter

CLERK CIRCUIT COURT
COLLIER COUNTY
EVERGLADES, FLORIDA

June 4, 1942

Dr. R. V. Allison
University of Florida
Gainesville, Florida

Dear Dr. Allison:

Many thanks for your letter of May 30th. with copy of Resolution looking toward continuation of the study of surface and ground water in south Florida.

I am very happy to note that a copy of this resolution has been sent to the leading Administrative Governmental Heads. I presume, when the proceedings of the Society has been published that these officials will be furnished with more detailed reports on the necessity for the continuation of the study.

You may be assured that I will cooperate whenever and wherever I can.

Sincerely,
ED SCOTT

A Resolution Commending Governor Spessard L. Holland for Refinancing the Everglades Drainage District.

Whereas, in 1941, when the Honorable Spessard L. Holland became Governor of the State of Florida, the Everglades Drainage District had been in default upon its obligations for ten years: virtually all of the lands in the district were delinquent in their taxes for substantially the same period; the Everglades Drainage District had ceased to function as a going concern; and

Whereas, the tax burdens imposed by the district were greater than the owners could bear and the debt of the district, of some $17,000,000.00, was greater than the district could ever hope to discharge, and

Whereas, all attempts on the part of the Legislature to reduce taxes, revise the tax structure and afford relief to the landowners had been declared unconstitutional, and

Whereas, all attempts on the part of the Board of Commissioners of the Everglades Drainage District and landowners to negotiate a bond refunding and refinancing program had come to naught, and

Whereas, by reason of the conditions aforesaid, the growth and progress of the Everglades area was being stifled and relief was imperative, and

Whereas, shortly after the inauguration of Governor Holland he assumed leadership in attempting to refinance the district and within a comparatively short time negotiated a settlement with the creditors of the district and secured the enactment of the necessary legislation to enable the consummation of a refunding program under which the debts of the district were reduced approximately 66 2/3% and the landowners were afforded great relief by a revised tax structure and an equitable tax compromise program.

Now, Therefore, Be It Resolved, that Governor Spessard L. Holland be and he is hereby highly commended by The Soil Science Society of Florida for his praiseworthy leadership and services in refinancing the Everglades Drainage District thereby affording much needed relief to the taxpayer and contributing to the future growth and prosperity of the Everglades area, and

Be It Further Resolved that this resolution be spread upon the minutes of the Society and a copy thereof be transmitted by the Secretary to the Honorable Spessard L. Holland, Governor of the State of Florida.

W. F. Therkildson, *Chairman*
Resolutions Committee
Soil Science Society of Florida

West Palm Beach, Florida
April 21, 1942

STATE OF FLORIDA
EXECUTIVE DEPARTMENT
TALLAHASSEE

SPESSARD L. HOLLAND
GOVERNOR

RALPH DAVIS
EXECUTIVE SECRETARY

June 4, 1942

Mr. R. V. Allison, Secretary-Treasurer
College of Agriculture
Gainesville, Florida

Dear Sir and Friend:

Your letter of May 30 and the Resolution by The Soil Science Society of Florida commending my efforts on behalf of refinancing the Everglades Drainage District are deeply and sincerely appreciated.

It is good to know that such fine and able citizens are working with me in this effort to improve conditions in our State and that I can always count on their loyal and effective cooperation. Working together, we have accomplished much and we shall, I am confident, accomplish much more.

The appreciation of my part in the undertaking, shown by your kind letter and by the Resolution of The Soil Science Society, warm my heart and inspire me to strive to measure up to what you and your associates expect of me. Credit for progress made in the Everglades and for the refinancing plan, specifically mentioned in the Resolution, should be widely distributed and no one knows better than I that members of The Soil Science Society are entitled to no small measure of it. I am glad that I was able to contribute to the successful accomplishment of that objective and you may be sure that I stand ready to work with you and other good Floridians in the future.

Please convey my thanks to the Society and my wish that I may be permitted to be of service to the Society and its membership whenever that opportunity is offered.

With kindest regards, I remain

Yours faithfully,

Spessard L. Holland

Governor

SLH:SW

A Resolution Commending Certain Landowners and Persons for Their Invaluable Assistance in Refinance the Everglades Drainage District.

Whereas, this Society has previously gone on record as favoring a resolution praising Governor Spessard L. Holland for his leadership in refinancing the Everglades Drainage District, and

Whereas, certain landowners greatly contributed in securing such refinancing, notably United States Sugar Corporation, Bessemer Properties, Inc., and Brown Company, and

Whereas, in the negotiations leading up to the refunding and preparation and passage of the 1941 Everglades Act authorizing such refunding, and conferring much needed relief upon overburdened landowners, United States Sugar Corporation furnished the services of its attorneys, Luther Mershon and W. G. Troxler, Bessemer Properties, Inc., furnished the services of its attorney, R. C. Alley, and Brown Company furnished the services of its attorney, R. K. Lewis, and its engineer and tax expert, W. Turner Wallis, and

Whereas, the gentlemen representing the landowners in 1940 spent months in Washington, New York and elsewhere, negotiating with Reconstruction Finance Corporation, the Everglades Bondowners Protective Committee, and other creditors of the district, thereby laying the foundation for the refinancing program which was subsequently brought about under the leadership of Governor Spessard L. Holland, and

Whereas, these gentlemen in 1941 brought the problem to the attention of Governor Holland shortly after his inauguration, enlisted his active leadership in handling the situation, and

Whereas, these gentlemen advised and counselled with the Governor and the Everglades Drainage District Board in the final negotiations culminating in the refinancing program which was put into effect, and

Whereas, they prepared the necessary legislation, and

Whereas, Mr. J. E. Beardsley, member of the Board of Comisioners of Everglades Drainage District, likewise played an important and leading part in all of these things.

Now, Therefore, Be It Resolved that United States Sugar Corporation, Bessemer Properties, Inc., and Brown Company be and each of them is hereby commended highly by The Soil Science Society of Florida for their public service in furnishing the able services of their respective representatives mentioned above, and

Be It Further Resolved that Mr. J. E. Beardsley be and he is hereby highly commended for his invaluable service in this connection, and

Be It Further Resolved that this resolution be spread upon the minutes of the Society and that a copy thereof be transmitted by the Secretary to each of the said landowners and Mr. J. E. Beardsley.

W. F. Therkildson, *Chairman*
Resolutions Committee
Soil Science Society of Florida

West Palm Beach, Florida
April 21, 1942

A Resolution Pertaining to the Great Necessity for a Complete and Unbiased Investigation and Report on Everglades Conditions with Specific Recommendations for Its Use as a Basis for a Comprehensive Plan of Conservation and Development for the Entire Area.

Whereas, extremely serious conditions pertaining to soil and water conservation of the Everglades Area have been pointed out and discussed in this conference called by the Soil Science Society of Florida in West Palm Beach on this 21st day of April, 1942; and

Whereas, conclusive proof has been submitted that great losses of soil and water resources have been sustained in the past from unrestrained and unplanned development and inadequate water control, and can be expected to continue in the future at increasing rates and with more serious consequence to agricultural development and domestic water supplies if existing conditions are not corrected; and

Whereas, the permanency of development and future conservation of the Area are threatened by present reclamation processes and agricultural activities which have exploited the organic soils of the Everglades and created serious losses of natural resources; and

Whereas, the indicated solution of the related problems concerning the conservation and development of the natural resources of this Area lies in the determination and adoption of an over-all plan of appropriate land use and reclamation: and

Whereas, the survey, research and experimental work of various governmental and private agencies during recent years has resulted in an increased knowledge and appreciation for the conservation needs of the Area, and has contributed important data not available at the time past engineering examinations, reviews and reports were made; and

Whereas, present existing data have not been fully assembled, analyzed and made available for the information and guidance of those interested or concerned with the problems of the Everglades Area.

Now, Therefore, Be It Resolved that this condition be called to the attention of the Governor of Florida, of the Trustees of the Internal Improvement Fund, of the Board of Commissioners of Everglades Drainage District, and other interested public agencies; praying that relief of present situation be afforded at the earliest possible moment, through the employment of a competent engineering commission, authorized to investigate all existing situations and examine all existing data of every type relating to the character and use of land; present conditions of tenure and reclamation, including the facilites of Everglades Drainage District, and of its sub-districts; and other reclaimed lands; with definite instructions to prepare a full and complete report on the problems of the Everglades, with specific recommendations for an over-all Plan of Reclamation which will prevent the present wasteful abuses, protect the present development and conserve the large areas of unused lands to the fullest extent.

Be It Further Resolved that a copy of this resolution be sent immediately to the Honorable Spessard L. Holland, Governor of Florida, and to each member of his Cabinet prior to its release to the press and publication in the Fourth Proceedings of the Soil Science Society of Florida.

W. F. Therkildson, *Chairman*
Resolutions Committee
Soil Science Society of Florida

West Palm Beach, Florida
April 21, 1942

APPENDIX

A BRIEF HISTORY OF THE FLORIDA EVERGLADES [1]

J. E. Dovell[2]

It has been said that Florida was the first state to be discovered and the last to be developed. The truth of this statement is nowhere better illustrated than in the history of the Everglades. Ales Hrdlicka in ANTHROPOLOGY IN FLORIDA[3] pointed to this, saying, "Of course the few as yet but very imperfectly explored regions in the United States the largest perhaps is the southernmost part of Florida below the 26th parallel of northern latitude. This is particularly true of the central and western portions of this region, which inland are unmapped wildernesses of everglades and cypress swamps." There is little doubt that man occupied Florida as early as the Pleistocene age. There is no knowledge as to how many occupations, pre-historic or historic, may have occurred.

The earliest Spaniard to reach Florida as we recognize the peninsula, Ponce de Leon, found the area peopled by sedentary Indians. There exists no evidence as to the origin, arrival or blood relation of these aborigines, though they were found to have had some contact with other continental tribes and with Cuba.[4] Brinton divided the regions of Florida as occupied by the aboriginal Indians into several districts. Two of these covered most of the Everglades: from Canaveral to the tip of the Peninsula on the east coast lay the province of the Tequesta, and the Caloosa or Calos inhabited the west coast area up to Ft. Myers and around Lake Okeechobee.

When Ponce de Leon made his landing on the east coast of Florida in search of the traditional fountain, there is good reason to suppose he was also in search of even more material wealth. The Spanish explorer no doubt had heard tales of the Caloosa, for on his second voyage to the continent he chose the western coast for his itinerary. When the explorer attempted to land near Ft. Myers in 1513 his forces were met by a fleet of 80 canoes filled with Indians.[5] The Spanish were compelled to withdraw after an all day fight. "Even at this early date they (the Calos) were noted among the tribes for their golden wealth which they had accumulated from numerous Spanish wrecks cast away upon the keys in passage from the south and two centuries later they were regarded as veritable pirates, plundering and killing without mercy the crews of all vessels, excepting the Spanish, so unfortunate as to be stranded in their neighborhood."[6] The name Caloosa, defying interpretation, appears in the early French and Spanish records as Calos and Carlos, in the English, as Caloosa and Carloosa, and survives today in Caloosa village, Caloosahatchee River, and Charlotte Harbor.

The French protestants turned to the southern coast of North America for settlements when Jean Ribaut attempted to plant a colony on the St. Johns River in 1564. The French colony was short-lived, being destroyed by the Spaniard Pedro Menendez de Aviles the following year. The little French colony was twice visited by Laudonniere, who later published a history of his voyages. From Laudonniere's narartive, as well as those of the artist LeMoyne who accompanied him, it is possible to glean something of Lake Okeechobee and the Everglades area in the late 16th ceetury. During the time of Laudonniere's second visit to the Florida colony stories were

[1] This article is a synopsis of a doctoral dissertation in progress at the University of North Carolina.

[2] Born in Florida and educated in Orlando public schools, graduate of Stetson, A. B. 1933 and M.A. 1934. Taught History in Orlando schools six years, more recently Professor of History, Flora Macdonald College, Red Springs, N. C., and graduate student University of North Carolina, Chapel Hill.

[3] Ales Hrdlicka, ANTHROPOLOGY of FLORIDA, DeLand, Florida. Florida State Historical Society, 1922, p. 57.

[4] Daniel G. Brinton, NOTES ON THE FLORIDA PENINSULA, Philadelphia, J. Sabin, 1859, p. 112.

[5] James Mooney, Bulletin 30, Bureau of American Ethnology, I, 195-196.

[6] *ibid.*, p. 196.

heard of foreigners living with some of the Indian tribes. The French offered rewards to the Indians who would bring such persons to them. Two Spaniards were brought into the French village. When questioned as to how they got to Florida, these men related that they had been in an expedition which had been wrecked on the Florida reefs and that they had fallen into the hands of the Calos Indians.[7] According to these Spaniards the village of the Calos lay on a river 50 miles beyond the promontory of Florida that pointed south. These men further related how they had made a trip from the west coast to the east coast, passing through a large body of fresh water in which there was situated a large island. There inland Indians carried on a trade in palm dates and root flour with the coastal Indians.

On his crude map of Florida, LeMoyne placed the Calos territory at the southern end of the peninsula, Canaveral as it appears today, and the large lake and island between the two points, in the interior. Fontenado described the Calos as masters of a large section of the southern part of the peninsula as far as a town on the "Lake of Mayaimi, which is called Mayaimi because it is very large."[8] On the margin of the lake he had been told there were many little villages of thirty or forty souls each. According to Fontenado these people of the interior made bread of roots, which was the common food for the greater part of the year, but that in some seasons the lake rose so high the roots could not be reached and in consequence they were sometimes without this food.

After Menendez reduced the French colony he established St. Augustine and returned to Cuba, where he developed a plan for exploring the southwest coast of Florida. He had learned that Christians were being held captive by the Calos Indians, so in February, 1556 an expedition set out for the west Florida coast under the leadership of Menendez. He landed in the vicinity of Ft. Myers, but received little satisfaction and left for Cuba. In the summer of 1566 Menendez deputized one of his officers to return to Calos with a company of 30 men to erect a fort and seek a water route to Lake Mayaimi through which communication could be established with St. Augustine.[9] The wily Calos tried to kill the Spaniards and they returned to Havana without fulfilling their task. "In 1567 the Spanish established a mission and fort among the Calos, but both seem to have been discontinued soon after, although the tribe came under Spanish influence."[10] From 1600 the Calos carried on a regular trade with Cuba by canoe and as the Indians from the north pushed into Florida, the Spanish Indians were gradually driven to the keys and to Cuba, many of them migrating to the latter on the transfer of Florida to the English in 1763.

At the close of the 17th century, after conflict internally and with the whites, various Indian tribes from Georgia and Carolina moved into Florida: the Yemasees and Uchees from Carolina and the Seminole-Creek from Georgia and Alabama. Many of the latter came with the English generals Moore and Oglethorpe, and remained in Florida, uniting with English and Spanish Negroes to form a renegade nation called Isthisemoli.[11] These Seminoles inhabited most of north Florida. It was not until the Seminole Wars of 1835-1842 that these northern Indians invaded south Florida, the Everglades and surrounding territory.

References to the Everglades during the 16th and 17th centuries are vague and confusing. The Spanish established missions at Tequesta near the present Miami, and, as before mentioned, at Calos on the West Coast, but these missions did not prosper. After Florida became an English colony in 1763 interest in the territory was revived. In William Roberts AN ACCOUNT OF THE FIRST DISCOVERY AND NATURAL HISTORY OF FLORIDA, published in London in 1763, reference is made to the "Laguna del Espiritu Santo. . . situated between the islands, extending from north to south about 27 leagues . . . near eight leagues wide." In a map in this work the lake occupies about the same position as the present Okeechobee. It was represented as having communications with the bays on the south and west of the peninsula.

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[7] Jacques LeMoyne, NARRATIVE OF LeMOYNE, AN ARTIST WHO ACCOMPANIED LAUDONNIERE, 1564, Boston: J. R. Osgood & Company, 1875, pp. 10-11.

[8] Buckingham Smith, ed., "MEMOIR OF HERNANDO D'ESCALANTA FONTENADO." typescript in University of Florida Library, pp. 6-8.

[9] Woodbury Lowery, SPANISH SETTLEMENTS IN THE UNITED STATES, New York: G. P. Putnam's Sons, 1911, II, p. 263.

[10] James Mooney, BULLETIN 30, Bureau of American Ethnology, I, p. 196.

[11] Daniel G. Brinton, NOTES ON THE FLORIDA PENINSULA, Philadelphia, J. Sabin, 1859, pp. 61-65.

William Stork in his DESCRIPTION OF EAST FLORIDA, published in London in 1769, gathered information on the province in general. In discussing the Shark River section Stork wrote, "The cape and seacoast eastward of the river consist of swamp and highland, the latter not exceeding 2,800 acres in coarse reddish land, containing much moisture, whose luxurious plants are the pomegranate, arboreus grape vine, the chicasau plumb, the opunita, and a variety of unknown shrubs; the soil is as rich as dung itself, producing mangrove between 50 and 60 feet high. . ."[12]

The best accounts of the Everglades prior to the Seminole War are found in Charles Vignoles' OBSERVATIONS UPON THE FLORIDAS and John Lee Williams' TERRITORY OF FLORIDA. Vignoles made a lengthy trip around the peninsula and into the interior. He noted the various rivers of the lower east coast, Hillsboro, New and Rio Ratonnes, which headed in swamps and savannas connected with the "Great Glade."

"The Glade, or as it is emphatically termed the Never Glade (undoubtedly a typographical error, as on pp. 52-53 Everglade is used), appears to occupy almost the whole interior from about the parallel of Jupiter Inlet to Cape Florida, thence round to Cape Sable to which point it approaches very near, and northwardly as far as the Delaware river discharging into Charlotte Bay. . ."[13] Vignoles described the Everglades from the eastern side as having the appearance of a flat sandy surface mixed with large stone on which lay up to two feet of water with a growth of sawgrass and other water grasses so thick as to impede the passage of boats. He noted islands and promotories covered with hammock growth which he thought capable of cultivation, but placed in such inaccessible positions as to repel all efforts of penetration. This writer expressed the opinion that the Everglades morass was overexaggerated by the account of Indians, Negroes and refugee whites and that a sectional survey of the area would probably show rich pieces of land in detached spots.

The acquisition of Florida by the United States in 1821 witnessed little or no attention to the southern end of the state. The area remained one of mystery. John Lee Williams visited the lower east coast in 1828 and at Miami noted, "The Miame River is a small stream that issued out of the glades and enters Sandwich Gulf behind Cape Florida. . . The height of the glades above the tide has not been ascertained."[14] Inhabitants of the area told Williams that the glades were 40 feet above the sea and he felt confident that the drop was at least 20 feet. The fall of the various rivers emptying out of the glades led Williams to speculate on the possibilities of deepening the channels of the rivers which drained the area. In describing the Glades, Williams wrote, "The grassy border of this lake is usually covered with water during the winter season, not so deep as to hide the grass which is very thick and tall. During the summer, the ground is often dry and hard for ten miles from the timbered land. This tract is at all times stocked with game, and would afford a superior range for cattle. On viewing for the first time this singular region I was led into many reflections on its origin, capabilities, and future destination.

"Could it be drained by deepening the natural outlets? Would it not open to cultivation immense tracts of rich vegetable soil? Could the waterpower, obtained by draining, be improved for any useful purposes? Would such drainage render the country unhealthy? Many queries like these passed through our minds. They can only be solved by a thorough examination of the whole country. Could the waters be lowered ten feet, it would probably drain six hundred thousand acres: should this prove to be a rich soil, as would seem probable, what a field it would open for tropical production."[15]

The Seminole Indian Wars were but a phase of the general movement in the United States in the 19th century to push the Indian farther west. The movement in Florida differed from that in the Mississippi Valley in that in Florida the movement was from north to south rather than east to west. American pioneers moved in from adjoining states or came by boat to the east and west coasts. One of these pioneers, Dr. Henry Perrine, secured a township grant in the Biscayne Bay area in 1838. It was his intention to experiment with tropical crops on his grant, but while waiting at Indian Key to take possession, Perrine was murdered by Sanish Indians.

[12] William Stork, A DESCRIPTION OF EAST FLORIDA, London, 1769, p. 12.

[13] Charles Vignoles, OBSERVATIONS UPON THE FLORIDAS, New York: Bliss & White, 1832, p. 50.

[14] John Lee Williams, THE TERRITORY OF FLORIDA, New York: A. T. Goodrich, 1837, p. 50.

[15] *ibid.*, p. 151.

As the whites encroached on the Indian lands in Florida, the Indians moved southward. Various treaties were made, by devious means, to remove the Indians to the territories of the West. Many of the Indians refused to migrate, hence the need for the search of south Florida swamps and Glades by the armed forces of the United States.

The massacre of Dade and his men on December 28, 1835, marked the beginning of warfare. The Seminole conflict was marked by few true battles; rather it was a series of raids, ambushes and guerilla warfare. The largest skirmish was fought on the northern shore of Lake Okeechobee on Christmas day, 1838, between the American forces under General Zachary Taylor and the Indians. The Americans succeeded in routing the Indians who fled to isolated spots of south Florida. During the years 1938-1842, inclusive, the Seminoles were gradually hunted down, most of them being taken captive and sent to the western lands, while the remainder escaped into the areas south of the Caloosahatchee and Lake Okeechobee. General Thomas Jessup wrote the Secretary of War in regard to the foolishness of seeking to transfer Indians from one wilderness to another. Jessup wrote that his men were not soldiers, but explorers whose ignorance of the interior of Florida was as deep as that of China.

In the winter and spring of 1841, operations of Colonel William S. Harvey and others from Fort Pierce "south and west, extending from the coast to Lake Okeechobee, thence through the Everglades laid open the country, disclosing large fields once cultivated by the Indians, but the approach of the troops had driven them still further into their fastnesses."[16] Later in the fall of 1841 Lt. John T. McLaughlin commanding a naval squadron of 150 seamen and marines passed up the Caloosahatchee River into Lake Thompson and over to Fisheating Creek. The squadron, moving in large rowboats, scoured the shores of Lake Okeechobee, crossed into the Loxahatchee River, the Glades, Snake Creek, Rio Ratones, and Key Biscayne. The McLaughlin expedition was but one of many which scouted the Big Cypress, as well as the Upper and Lower Glades.

Sprague gives an illustration of one scouting party in the Glades which was caught in a period of hot weather and failing water. "The fatigue and privation undergone by this detachment was so great that Private Kingsburry fell in his trail and died from sheer exhaustion. The water of the Everglades had fallen so low that it was necessary to track the boats at all times; and at times to make ways of the boats' seats for miles and miles to slide them over."[17]

President John Tyler in a mesage to Congress on May 11, 1842, announced that there were but 240 Indians left in Florida and since summer was approaching he asked that a peaceful and voluntary solution be made allowing the military operations to be confined to the protection of the citizens of Florida.

The most significant results of the Seminole War were the reports brought back by the men in the armed services regarding the hitherto unknown lands and waters of South Florida. Engineers had mapped the area, and all of the "exploring" soldiers had seen the fertile islands inhabited by the Indians. Some of these islands were twenty or more acres in extent, covered with an extremely rich soil and intensively cultivated. Indian crops included pumpkins, squash, melons, beans, Cuban tobacco, corn, sugar cane and bananas. Many of the men who fought in the Everglades remained in Florida and undoubtedly remembered the primitive gardens on the little islands.

The people of the territory of Florida recognized the needs of internal improvements some years before Florida entered the Union. In the St. Joseph constitution, adopted by the convention which assembled in 1838, Article XI, Section 2, it was stated that a liberal system of internal improvements was essential to the development of the resources of the country and that such work should be encouraged by the government of the state. Seven years after the adoption of the St. Joseph constitution Florida was admitted into the Union, March 3, 1845. Ten months later the legislature of the young state passed a resolution concerning certain land in the state which had hitherto been considered valueless, adding: "now reported by respectable sources that the Everglades . . . at a comparatively small expense, can be entirely reclaimed, thus opening to the habitation of man an immense and hitherto

[16] John T. Sprague, THE ORIGIN, PROGRESS AND CONCLUSION OF THE FLORIDA WAR, New York: D. Appleton & Company, 1848, p. 261.

[17] *ibid.*, p. 389.

unexplored domain perhaps not surpassed in fertility and every natural advantage by any other on the globe."[18]

The resolution of 1845 was pushed into the Congressional arena by Florida's Senator James D. Wescott, Jr., in 1847. Wescott wrote a letter to Secretary of the Treasury R. J. Walker in which the senator noted the repeated demands made to the state legislature and its resolutions on the matter. The senator asked that an agent be sent to make a reconnaisance of the lands and to submit reports as to the practicability of the work of draining them, such reports to be laid before Congress at the next session. Secretary Walker did not delay in seeking authentic information. He employed as agent Buckingham Smith, a son of Florida educated at Harvard Law School, former Governor's secretary and thrice member of the state legislative council. Walker, in his letter to Smith, cited information as reported that the several million acres could be reclaimed and rendered valuable by two or three small canals from the Everglades into the rivers emptying into the gulf or straits of Florida. Walker further urged Smith to obtain information in writing from citizens acquainted with the subject.[19]

Among bills submitted to the first session of the thirtieth Congress in 1848 was one introduced by Florida's Senator Wescott which would have given to the peninsula state all lands, lakes, and watercourses south of Township 36 South. The grant was to be made under certain conditions.[20] This bill did not pass. By resolution of August 9, 1848, the Senate requested the Secretary of the Treasury to communicate to the Senate any information in his department relative to reclaiming the Everglades or of the expediency of ceding them to Florida for that purpose. Secretary Walker sent the Buckingham Smith report and accompanying letters. The Secretary also cited Smith's figure of $500,000 for drainage of the Everglades as well as the divided opinion as to whether the Glades were worth draining, and concluded with the statement that "The test of experience can alone solve the doubt."[21]

The report on the Everglades by Buckingham Smith as submitted to the Senate in 1848 represents the first authentic information on the Everglades and remains today a monument to the efforts of the man who gathered the material. The fact that the Everglades received its water from the overflow of Lake Okeechobee, which in turn received most of its water from the Kissimmee River, was probably known, but Smith was the first to publicize it. He estimated the average elevation of the Glades to be 12 feet above sea level, covered with water in the fall of the year to a depth of 6 feet.[22] Smith advanced the idea that by cutting the rim of the Glades on the east and west coasts at the heads of the various streams that received their initial waters at low places in the rim some four or five feet of water might be drained off the area. It was Smith's belief that the land so reclaimed would be profitable for the cultivation of coffee, sugar, rice, corn, cotton and tobacco. The soil deposit under the water he found to be exceedingly light when dry and an impalpable powder when broken. "The Everglades are entirely below the region of frost, and the meteorlogical and barometrical statistics . . . prove that the climate is as favorable to the cultivation of tropical fruits as that of any country between the twenty-eighth and twenty-fourth parallels. . . ."[23]

With his report, Smith submitted a number of letters, some of which may be noted. From Colonel R. Butler, surveyor general of Florida, came the dictum that the Everglades could not be surveyed until drained. This gentleman advised the granting of the area to the state of Florida, since the Everglades were in the interior of the state and were without navigable rivers, and their reclamation by the Federal Government would conflict with the sovereignty of the state. He advocated the grant to the state of one moiety, conditioned that the state cause the glades to be drained within a given period; thus the United States would realize for survey and sale the other moiety and, "thus would be opened a large fertile surface for the habitation of man, cultivation of sugar and tropical fruits extensively thereon."[24]

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[18] U. S. Senate Document 89, 62nd Congress, 1st Session, pp. 34-35. (1911) (hereafter referred to as Sen. Doc. 89)

[19] *ibid.* pp. 37-38.

[20] *ibid.*, p. 43.

[21] *ibid.*, pp. 39-40.

[22] *ibid.*, pp. 46-48.

[23] *ibid.*, p. 53.

[24] *ibid.*, p. 55.

General Thomas S. Jessup, who commanded Federal troops in Florida during the Seminole Indian Wars, wrote Senator Wescott, "The swamps (in the Everglades) are generally peat swamps, which if drained, would soon be converted into olive, lime and orange plantations and would be cultivated by a numerous white population, which would be interposed between the sugar plantations, cultivated by slaves and the free blacks of the West Indies."[25] General W. S. Harney had made several long trips through the Everglades and wrote Buckingham Smith that canals from Lake Okeechobee to both the Caloosahatchee and the Loxahatchee should be dug, as well as canals into the Ratones, Little, Arch Creek, Miami and Shark rivers. Harney even went so far as to write that the two chief canals should be ten to fifteen miles long, thirty feet wide and from five to fifteen feet deep. "No person can say with positive certainty what the soil of the Everglades when drained would or would not produce; but it is my opinion it would be the best sugar land in the south and also excellent for rice and corn."[26]

One of the correspondents from whom Smith sought information regarding the Everglades was Stephen R. Mallory, Collector of Customs at Key West, Florida. Mallory had been in the state for many years and was the only person whose opinion Smith received who had actually lived in the southern part of the state. This man, later to become a United States Senator and Confederate Secretary of the Navy, had spent time in the Glades area. "My own impression," wrote Mallory, "is that large tracts of the Glades are fully as low as the adjoining sea, and can never be drained; that some lands around the margins may be reclaimed by drainage or by dyking, but that it will be found wholly out of the question to drain all the Everglades. As the country now is healthy and mild, with its good lands in small parcels, with water at hand everywhere for irrigation, I think it offers inducements to small capitalists, men with from one to ten hands, to go there and raise fruits."[27]

The Smith report with accompanying papers was sent to the Senate Committee on Public Lands which recommended the bill be adopted. The Committee felt that if the proposed improvements were carried out the United States would derive pecuniary benefit, at no expenditure, in bottom lands in the Kissimmee River valley and in the Everglades. In addition, "The proposed canals being made channels of communication by vessels across the peninsula from the Atlantic to the Gulf waters, thus avoiding the perilous reefs further is a consideration of no trifling moment to the navigating interests of the Union."[28]

The Congress did not pass the Wescott bill in 1848, but on September 28, 1850 that body did pass the Swamp and Overflowed Lands Act, an answer to the requests of Arkansas, Florida, and other states seeking inundated lands within their several borders. This act gave the Everglades area to Florida and thus the destiny of that great "grassy water" passed from Federal into State hands. The Florida legislature in session the following January of 1851 passed an act to secure the swamp and overflowed lands lately granted to the state which is still in force today. This act consolidated grants made to the state on its entrance into the Union with those secured by the 1850 Act in a separate and distinct classification from other state lands to be known as the Internal Improvement Fund. All lands and funds arising from the sale of such lands which were a part of this fund were irrevocably vested in five trustees: the governor, comptroller, treasurer, attorney-general and the register of state lands and their successors. In addition to making stipulations in regard to sale, transfer, or investment of proceeds from lands sold out of this fund, the Act provided for aid to railroads, canals or other works of an internal improvement nature. The trustees were given power to fix prices of these lands and to make such arrangements for the drainage of the swamp and overflowed lands as in their judgment appeared most advantageous to the Internal Improvement Fund.[29]

In the decade before the Civil War the gradual settlement of isolated villages in the interior and along both coasts was accompanied by military operations for exploring and surveying the southern parts of the state. Military posts on Tampa Bay, in the Caloosahatchee valley, at Fort Lauderdale and Fort Dallas (Miami) gave protection to the hardy pioneers who were making their home on this southernmost frontier. The War Department maintained skeleton forces at these posts, and at the

[25] *ibid.*, p. 56.
[26] *ibid.*, pp. 60-61.
[27] *ibid.*, pp. 62-63.
[28] *iid.*, pp. 44-45.
[29] Florida Statutes, Number 21, Chapter 332, 1851.

same time kept the soldiers occupied in surveying operations. In 1854 a detachment of eleven men under Lt. George L. Hartsuff was authorized to survey the swamp regions southwest of Fort Myers and to make topographical reports.[30] The Hartsuff command was ambushed and four of its number were killed. This incident renewed the actual warfare with the Indians. Most of the action was of a desultory nature, resulting in the capture and shipment of a number of the remaining Seminoles to the West. With the coming of the Civil War the attention of the troops and the citizens was concentrated on other fronts. Bogges in his VETERAN OF FOUR WARS, commenting on the operations in Florida from 1855 to 1858, wrote, "There is something remarkable about moving the Seminole Indians from the Everglades as they are not suitable for the white man. The Indians want them and should be allowed to remain."[31]

The conflict between the states from 1861 to 1865 put a temporary end to all plans for internal improvements in the southern end of the state until past the three-quarter mark of the 19th century. "In the years of reconstruction," wrote Kathryn Abbey, "the Republicans made an effort to restore Florida's transportation and revive her development . . . while their efforts evidenced a genuine perception of the needs of the state, their policies were so linked with palm-greasing that they were not always executed according to the public good, and the result was a deeper stagnation of affairs under new burdens of debt."[32]

Activity in south Florida during these years was limited in the main to the cattle industry. During reconstruction many families settled in the Manatee-Ft. Myers area and devoted their energies to cattle grazing. During the drier months of the year the cattle could be grazed on the flats bordering the Everglades, where the lush grass added pounds to the beeves that were shipped from docks on the Manatee and Caloosahatchee rivers to Havana.[33] At Tallahassee, meanwhile, the trustees of the Internal Improvement Fund were receiving proposals to ditch and drain land in or near the Everglades. On April 6, 1866, the trustees considered a communication from William H. Gleason who sought to enter portions of swamp and overflowed lands in South Florida and drain them.[34] In the same year the Trustees contracted with S. L. Niblack and others to drain and reclaim lands adjacent to the Caloosahatchee and Kissimmee rivers as well as Lake Okeechobee and any or all tributary areas. The contractors were to receive one-half of all such lands reclaimed if the work were begun within one year and completed in seven years.[35]

Among other powers granted to the Trustees of the Internal Improvement Fund at its creation in 1855 was one which allowed them to subsidize railroad or other forms of improvements with state lands or to guarantee interest on bonds floated by such enterprises. About 400 miles of railroad had been built in Florida prior to the Civil War, most of which had been constructed with money from bonds, the interest being guaranteed by the I. I. Fund. During the war and reconstruction, interest coupons on these bonds were mostly in default, and in 1869 Francis Vose, one of the large bondholders, instituted suit to enforce interest payments by the I. I. Fund.[36] By order of a U. S. Circuit Court a receiver was appointed for the Fund, and it was the sale of a large amount of land to Hamilton Disston which saved the fund to the people. "These coupons held by Vose, with interest—a little grasping, weazened-faced fellow, with a heart no bigger than a mosquito's gizzard—together with others holding coupons, who had intervened in the suit, amounted to considerably more than a million dollars, and the ordinary sales of land did not suffice to keep debt from increasing, but the fund was being eaten up by compound interest, costs, receiver's allowances, and other expenses of litigation, and it was obvious that

[30] Frances C. M. Bogges, A VETERAN OF FOUR WARS, Arcadia, Fla.: Champion Press, 1900, pp. 43-63; Andrew P. Canova, LIFE AND ADVENTURE IN SOUTH FLORIDA, Tampa, Tribune Printing Company, 1906, pp. 5-7. T. A. Gonzales. THE CALOOSAHATCHEE: MISCELLANEOUS WRITING CONCERNING THE HISTORY OF THE CALOOSAHATCHEE RIVER AND THE CITY OF FORT MYERS, FLORIDA, stero, Fla.: Koreshan Unity Press, 1932, pp. 30-40.

[31] Bogges, A VETERAN OF FOUR WARS, p. 63.

[32] Kathryn T. Abbey, FLORIDA, LAND OF CHANGE, Chapel Hill, University of North Carolina Press, 1941, p. 347.

[33] Lille B. McDuffie, THE LURES OF MANATEE, Nashville, Tennessee: Marshall & Bruce Company, 1933, pp. 197-200.

[34] MINUTES OF THE TRUSTEES OF THE INTERNAL IMPROVEMENT FUND, I, p. 276.

[35] *ibid.* 361-364.

[36] MINUTES OF THE TRUSTEES OF THE INTERNAL IMPROVEMENT FUND, I, 380, 498, 512-515.

only by making a sale of considerable quantity of the lands at one time could the fund be saved."[37] In the decade from 1870 to 1880 the I. I. Trustees made numerous attempts to sell enough of the several million acres of swamp and overflowed lands to pay off the sums sought by Vose and others.[38]

Hamilton Disston, of Pensylvania, had become interested in overflowed Florida lands and had submitted a proposition to the Trustees relating to drainage in January, 1881. In the following month articles of agreement were drawn up providing for the drainage and reclamation of all overflowed lands south of Township 23 East and east of Peace Creek, which belonged to the Internal Improvement Fund. At the same time the interests as represented in the Vose suit were seeking the release and sale of some fourteen million acres in the I. I. Fund to settle their claims. The Trustees under the leadership of Governor William D. Bloxham contacted Disston and arranged for the outright sale of four million acres of overflowed land for $1,000,000. The completion of the deal enabled the Trustees to satisfy their creditors and to place the Fund in an independent position with regard to further land disposition.[39] Disston and his associates secured a charter and transferred their interests to the Atlantic and Gulf Coast Canal and Okeechobee Land Company. The company entered negotiations with the Trustees to drain overflowed lands in the Kissimmee-Okeechobee area on a basis of deeding to the private enterprise one-half of all such lands that should be drained.

In late 1881 the Disston company began operations with the employment of several engineers, J. M. Kreamer, R. E. Rose, and others, who set about constructing dredges to be used in draining lands in south Florida. Rose, later state chemist for many years, built the first dredge at Cedar Keys and assembled it at Fort Myers. The dredge required three months to reach old Ft. Thompson on the Caloosahatchee, due to trees in the river. The dredge worked from July, 1882 until January, 1883, cutting a canal to Lake Okeechobee. Disston and a party of his associates made the first steamboat trip from Ft. Myers to Kissimmee City in February, 1883.[40] Most of the company's efforts were devoted to the area around St. Cloud, at the headwaters of the Kissimmee River, where extensive drainage works had been installed and the planting of various crops was already underway. During the high bounty period of the 1880-1890's, sugar production was undertaken at St. Cloud and the record of 5,000 pounds of pure granulated sugar per acre made there had not been equalled elsewhere in the Americas up to 1890. When Disston found the sugar yield satisfactory he organized a separate corporation with a million dollar capital. "The business was handled by promoters inexperienced in cane or other agricultural pursuits, and when the high bounty was taken off sugar the Disston company went into bankruptcy with hundreds of other sugar companies in the cane and beet fields of the country."[41]

In June of 1882 S. L. Niblack, agent for the I. I. Fund, made a report on the drainage progress of the Disston company. He reported that the company had two dredges at work, but that these were not enough to amply drain the Everglades. He advised the Trustees that it would require three or four canals from Lake Okeechobee to the Caloosahatchee, St. Lucie, New or Hillsboro rivers to do the drainage job.[42] The Disston company continued some drainage operations until the death of Hamilton Disston in 1896, but its efforts to drain the Everglades were a failure. The long-range value of the Disston works, however, cannot be over-estimated as a step in the development of the southern part of the state. Had the Vose interests forced a liquidation of the Improvement Fund lands it would have been disasterous in many respects. The Disston efforts proved that the waters of this part of the state could be lowered, but that drainage works would have to be maintained if they were to remain of value. The results of the sugar plantings and mill at St. Cloud proved what could be done on drained land and the record made there were not lost to the next generation. The committee appointed in 1885 to report on the work of the Disston company made a simple statement, but one that was lost to view in the plans and works of the three decades that followed: "The reduction of the waters is simply a

[37] REPORT OF THE JOINT COMMISSION OF 1907 ON THE INTERNAL IMPROVEMENT FUND, pp. 36-37.

[38] MINUTES OF THE INTERNAL IMPROVEMENT FUND, II, p. 67.

[39] Minutes of I. I. Fund, III, 53-58.

[40] Everglades News, (Canal Point, Florida), May 9, 1924.

[41] C. Lyman Spencer, THE SUGAR SITUATION, p. 88.

[42] MINUTES OF THE INTERNAL IMPROVEMENT FUND, III, 191. (Hereafter cited as I. I. F. MINUTES).

question of sufficient capacity in the canals which may be dug for their relief."[43]

The ANNUAL REPORT of the Secretary of Agriculture of the United States in 1891 carried a report by Dr. W. W. Wiley of the Bureau of Chemistry on Florida mucklands. The Disston sugar mill at St. Cloud had attracted the attention of the Department of Agriculture and Dr. Wiley had been dispatched to look over the situation. In his report he also mentioned the muck areas around Lake Okeechobee and in the Everglades. His suggestions for draining the latter area included a canal from Okeechobee to tide water 300 feet wide and 12 feet deep or by use of levees and pumps. "It is . . . seen there is abundant natural fall to carry off the whole of the water, provided a canal of sufficient size can be constructed."[44] He noted that these muck soils were purely organic in composition and markedly deficient in mineral constituents. "If the organic matter which they contain should decay there would, of course, be a marked depression in the soil."[45] "In no instance," wrote Wiley in regard to temperatures, "has cane been known to freeze in the Florida peninsula during the period over which observations have been extended. . . It may be said . . . with confidence that in the region of Okeechobee Lake the lands which may be recovered for sugar-making purposes have the advantages of Cuba."[46] In conclusion, Wiley wrote, "There is practically no other body of land in the world which presents such remarkable possibilities of development as the muck lands bordering the southern shores of Lake Okeechobee. With a depth of soils averaging, perhaps, 8 feet, and an extent of nearly half a million acres, with a surface almost absolutely level, it affords promise of development which reaches beyond the limits of prophecy."[47]

The work going on in the Kissimmee-Okeechobee region was widely publicized. Within the state itself the possibilities of the Everglades as heralded by the St. Cloud sugar development and reports such as that of Dr. Wiley did not fall on deaf ears. In February, 1892 at a meeting in Tampa at which were present H. B. Plant, H. M. Flagler, and J. E. Ingraham the subject of the possibilities of vegetable production in those areas was discussed. Plant, the founder of the system that later became part of the Atlantic Coast Line Railroad in Florida; Flagler, the developer of the Florida East Coast Railroad; and Ingraham, president of the South Florida road and later general manager of the Florida East Coast, were interested in opening a line from Tampa to Miami through the Everglades. At this meeting they organized the Ingraham expedition to run a line across the Glades, if it were found feasible.[48] The party of 22 men, making up the expedition, left old Ft. Shackleford, at the western edge of the Everglades, March 21, 1892. They had planned to cover an average of 5 miles per day, but some days were unable to make more than 2, and by March 27th the food supply was running low. Due to the low water in the Glades the party had a difficult and strenuous journey. "Locomotion is extremely difficult and slow. The bog is fearful and it sometimes seems as though it would be easier to stay in it than to go on. Both legs up to the waist frequently become embedded in the same hole in the mud, and to extricate oneself with from 30 to 50 pounds weight on the back requires strength and time. Packing for any distance is impracticable. A man by himself, carrying nothing, would probably fail to reach the timer line from this point. The boats are very necessary to enable one to pull himself out of the mud and even then the labor is most exhaustive."[49] On April 4th, two weeks out from Ft. Shackleford and five miles from the eastern edge of the glades, the party secured an Indian to guide them to Miami. The trip was exhausting and the men suffered many hardships, but they reported no evil consequences as a result of the experience.

In the years from 1888 to 1905 the Trustees of the I. I. Fund received a number of proposals from various persons to drain all or part of the Everglades.[50] In 1893 F. A. Hendry of Ft. Myers came before the board of trustees in behalf of certain

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[43] REPORT OF JOINT COMMITTEE TO INVESTIGATE DRAINAGE OPERATIONS. 1886., Sen. Doc. 89, pp. 21-24.

[44] *ibid.*, pp. 74-75.

[45] *ibid.*, p. 77.

[46] *ibid.* p. 78.

[47] *ibid.*, p. 79.

[48] FT. LAUDERDALE (FLORIDA) TROPICAL SUN, January 1, 1922.

[49] W. R. Moses (MSS), "EVERGLADES EXPLORING EXPEDITION." Carbon copy in Albutson Library, Orlando, Florida.

[50] I. I. F. MINUTES, IV, 42.

Lee County citizens who wished to enter and cultivate a tract of unsurveyed land near Ritta River bordering Lake Okeechobee to raise winter vegetables. "If you will kindly grant this request." said Hendry, "it will doubtless prove of great advantage in the way of showing the great value of these wastelands and prove to be of great interest to the State."[51] The board granted the request but no other reference can be found to its success or failure.

On December 16, 1898, the Trustees received a leter from R. E. Rose, secretary of the Florida East Coast Drainage and Sugar Company, in regard to that company's efforts in the Miami Everglades region. Rose wrote that he had employed engineers and crews to run lines into the Glades from the eastern boundary and that it was found that it would not be necessary to drain the whole area at once, but that it would be better to dike and canal portions progressively. Rose noted that the surveys showed a mean fall of 6 feet and 11 inches from the rapids of the Miami River to tidewater, with a slope of 7 inches per mile on the Glades from West to East. This fall, he thought, would be ample to drain a territory 30 miles broad ,and he added that if the territory were dyked and enclosed on the north and west, the area would be more quickly drained than if the "spill" from Lake Okeechobee were allowed to pass through the drains of this territory. Rose suggested the draining of hundred thousand acre tracts as district operations, beginning on the east and extending west. The company which Rose represented secured a contract to carry out drainage operations in the Miami-New River area of the Everglades, but later forfeited their claim through inactivity.[52]

Governor Bloxham, in his message to the 1899 legislature, cited the contract made by the Trustees of the I. I. Fund with the Florida East Coast Drainage and Sugar Company to reclaim 800,000 acres as proof of the march of improvement in Florida looking to the utilization of the Everglades lands. Although Bloxham was definitely interested in the Everglades problem, it remained for his successor, W. S. Jennings, to begin laying the actual groundwork for drainage operations. By resolution of July 3, 1902, the Trustees went on record to the effect that under Section 16 of the Internal Improvement Act of 1855 (Statutes of Florida, Chapter 610) the Trustees were required to make such arrangements for swamp and overflowed lands as in their judgment might be most advantageous to the I. I. Fund.

When Governor Jennings spoke to the 1903 session of the State Legislature he dwelt at length on the Everglades, tracing the history of the area from 1835, emphasizing the fact that the lands had not been salable because undrained and that they could not be drained because they could not be sold. He placed the state in the position of the man who undertook to lift himself. The governor urged that the state undertake the drainage problem by cutting the rockrim barriers on the edges at the heads of all the streams on both sides from the Halpatiokee to the Caloosahatchee, a feat which would enable the Glades to drain themselves.[53] In order to secure information of a scientific nature Governor Jennings obtained the services of C. G. Elliott, engineer in charge of drainage operations and investigations for the U. S. Department of Agriculture. Elliott made a reconnaissance of the Glades lands in the Miami area, noting the drainage work that had been done by the Florida East Coast Railroad. The railroad had spent a considerable sum of money to open and enlarge the natural streams of the region leading from the Glades for the purpose of lowering the water in the various arms of the Glades during the winter season to facilitate the production of winter vegetables. The drainage of the Everglades proper, Elliott found, would necessitate dredging to a grade of 0.3-0.4 feet per mile to the center of the area, and that one channel would afford only flood relief since the area was too level and the water flow too slow for good drainage. "This makes it necessary to dredge all of the natural streams into or through the Everglades as far as the divide between the eastern and western slopes . . . all of this work must be done before this area of approximately 3,500 square miles can be drained sufficiently for summer culture."[54] The problem in 1904, Elliott reported, is one of what can be done to fit portions of the land for the production of crops. He advocated an experimental plan of enclosing small areas with dikes and using inside pumping.

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[51] *ibid.*, pp. 239-240.

[52] *ibid.*, 454-455.

[53] JOURNAL OF THE HOUSE OF REPRESENTATIVES OF FLORIDA, 1903, pp. 87-97.

[54] Sen. Doc. 89, p. 96.

As the Florida constitution prohibited Jennings from seeking a second term, the cause of Everglades drainage was carried into the governor's race of 1904 by one of Florida's most picturesque characters—Napoleon Bonaparte Broward. With a screen and a colored map of the state Broward made the campaign a referendum on the Everglades proposition. He repeated many times: ". . . the Everglades could be drained so as to make it worth a hundred dollars an acre by the cutting of a canal 1100 feet long."[55] Broward, a former filibusterer in the days preceding the Spanish-American War and later sheriff of Duval County, won the governorship and did not hesitate to introduce his plans for drainage to the legislature in 1905. He urged the cutting of a canal from the big lake into the St. Lucie River, a distance of 24 miles, to lower Lake Okeechobee from 18 to 12 feet and thus reclaim six million acres. The proposed St. Lucie Canal of 24 miles, 200 feet wide and 15 feet deep, could be built in 18 months by four dredges at a cost of $250,000. Broward told the legislature. He also said that the dredges could be at work six months after the contract was signed. The area drained would ". . . be capable of producing the entire tonnage of cane sugar used in this country."[56] Broward ended his speech by recommending a statute creating a drainage district to be administered by the trustees with power to make assessments for benefits from such an organization.

On May 27, 1905, the legislature passed an act which created a Board of Drainage Commissioners to consist of the governor, comptroller, treasurer, attorney general, and commissioner of agriculture. The act empowered the board to establish a system of canals, dikes, and so forth to drain and reclaim the swamp and overflowed lands of Florida. The act further empowered the commissioners to levy drainage taxes up to 10 cents per acre per year to be assessed in districts of their creation. The board was given the powers of a body corporate and also the right of eminent domain.[57] It may be noted that the members of the board of commissioners above constituted also the board of Trustees of the I. I. Fund.

Several months after the passage of the above act two dredges were contracted for to begin drainage operations in the Everglades.[58] On November 14, 1905, the commissioners hired J. W. Newman as engineer in charge of operations. Newman had been engaged prior to this in surveying a route for the first canal, and his survey was adopted for the first operations. This canal when finished became the present North New River Canal. By 1907 the dredging was well under way in both branches of the New River, west of Ft. Lauderdale. Governor Broward, in his message to the 1907 legislature, outlined the commissioners' plan to build four more dredges. Two were to be put in the Miami River, one in Lake Okeechobee to meet the New River cuts, one in the Caloosahatchee, and one in the Kissimmee, taking one of the dredges off the New River operation at Ft. Lauderdale. The governor stated that the commissioners had expected the drainage taxes to be paid, but instead were being sued by large landholders who sought to enjoin such tax collections. Broward concluded by asking for a legislative committee to investigate the commissioners' drainage works which were being subjected to what he considered unjust criticism.[59]

The trend of events in the Everglades may be gleaned from a resolution passed by the I. I. Trustees in February of 1907, to the effect that no swamp or overflowed land owned by the Fund in the drainage district would be sold for less than $5 per acre unless subject to salt water overflow. Eight years before, the value of the best land in the Everglades had been only 40c-50c an acre. The suit which had been instituted against the drainage tax levies collection was successful and the power of the board to tax was declared unconstitutional in the early spring of 1907. Broward, in a special message to the legislature, advocated a new drainge law, setting up a special district in the Everglades. The legislature complied with Broward's wishes and passed an act defining the boundaries of the Everglades Drainage District, encompassing most of the mainland area east and south of Lake Okeechobee. The new act provided for a 5c an acre drainage tax.[60]

Meanwhile the dredges at the head of the New River continued their operations. Reports to the commissioners showed that water was six feet below the surface of the land along the canal. "That the canals are a success and are reclaiming the land

[55] FLORIDA TIMES-UNION, April 8, 1904.
[56] Sen. Doc. 89, p. 107.
[57] FLORIDA STATUTES, Chapter 5377, May 27, 1905.
[58] I.I.F. MINUTES, VI, p. 96.
[59] HOUSE JOURNAL, 1907, pp. 3, 14-18.
[60] STATUTES OF FLORIDA, Chapter 5709, 1907.

as the dredges progress is thoroughly established."[61] In the early months of 1909 the dredges had cut seven miles from the north and south branches of the New River. The new dredges were built and scheduled to begin excavations in the Miami and Caloosahatchee rivers. Land sales by the Trustees were reaching boom-time proportions: R. P. Davie and others bought 25,000 acres at the rate of $2.00 per acre in the area around Township 50, Range 41 South and East, where they planned to plant sugar cane and construct mills; J. H. Tatum and R. P. Davie bought 80,000 acres at $1.25 per acre in Dade County; R. J. Bolles contracted for 500,000 acres in Dade County and Lee County at $1.00 an acre. The Bolles sale was made with the specifications of installments over a six-year period, depending on when certain canals were cut. The articles of agreement Bolles made with the Trustees and Drainage Board Commissioners specified that there be dug five main canals; North and South New River, Miami, Hillsboro, Caloosahatchee and two secondary canals, Cypress Creek and Arch Creek.[62] The boards had, in the Bolles deal, contracted irrevocably for the cutting of certain canals if the purchaser completed his contract. Land sales for the previous two years had totalled $158,000; $35,000 in 1907, $123,000 in 1908.

When Broward left office his dreams of Everglades drainage had been translated into partial accomplishment. "When some insisted that it would take fifteen years of rainfall observations, several years of careful topographical surveying and the reports of several expensive and conflicting experts to determine the feasibility of his scheme, he was abashed, but not discouraged. He replied, "I will be dead by that time. The state will be poor and the money thus expended would buy a couple of dredges. We can sell some land to build dredges and if my friends will hold the knockers in check, we can soon make a convincing ocular demonstration."[63]

In 1906 the drainage board requested the Office of Drainage Investigations in the United States Department of Agriculture to make a thorough examination of the Everglades for the purpose of ascertaining the practicability of reclaiming the area and making it profitable for agriculture. Field examinations were made in the winters of 1907 and 1908 by J. O. Wright, supervising drainage engineer. The report of Wright, proposing a plan for draining the land, was submitted in 1909. After examining Lake Okeechobee and its watershed, running lines across the Everglades from west to east, and along the borders, Wright submitted two plans: construction of an 80 mile dike around the southern shores of the big lake with outlet canals for drainage and water control, and second, construction of one or more outlet canals from Okeechobee to tidewater. The first plan Wright rejected on account of the expenditure of an estimated $5,300,000 for construction plus the possibility of backing waters on lands on the opposite side of the lake. Wright advocated the construction of 8 canals from the big lake: Caloosahatchee, Hillsboro, Palm Beach, North, Middle and South New Rivers, Miami and West. His plan for West canal proposed cutting this outlet from the present location of Clewiston to the vicinity of the Big Cypress swamp. Wright sought a combined discharge of some 4,000 cubic feet per second at the lake and 10,000 at the tide water outlets to take care of both lake discharge and the runoff along the canal banks as they passed through the Glades. Wright estimated the total cost of canal excavations of $1,900,000. "The upper Everglades comprise an area of approximately 1,850,000 acres, lying south of Lake Okeechobee, and is the only part in which the depth of the muck will warrant the expense of reclaiming."[64] Wright noted that as far as could be ascertained the fertility of the Everglades muck was the same as that of the Kissimmee River valley at St. Cloud, where the Disston company agricultural operations were carried on from 1888 to 1898. Wright concluded his report by stating that the drainage of the Everglades by gravity canals with control gates was feasible and he recommended this plan of main canals, 8 miles apart, leading southeast, south and west from Lake Okeechobee to tidewater, except for West Canal. Wright's plan did not include the subsidiary lateral canals which he said would be essential, but which he recommended be dug by the local districts involved.

The 1909 session of the legislature created a joint committe to investigate the drainage operations which were being carried on by the Board of Drainage Commissioners. The committee visited the dredges working in canals leading from the

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[61] I.I.F. MINUTES, VII, 122-125.

[62] *ibid.*, 261-265, 447-448, 572, 485-490, 502-512.

[63] J. C. Gifford, THE EVERGLADES AND OTHER ESSASYS RELATING TO SOUTHERN FLORIDA, Kansas City, Missouri: Everglades Land Sales Co., 1911, pp. 98-99.

[64] J. O. WRIGHT REPORT, Sen. Doc. 89, p. 179.

branches of the New River and saw the work being done there. The committee also interviewed a number of farmers at the edge of the Glades as well as other persons in the locality. In its report to the legislature the committee announced its approval of the drainage plans and endorsed the Wright report, and further recommended that the legislature inform the people of Florida as to what was being done in the Everglades and enlist the cooperation of every citizen in reclaiming the vast and invaluable domain in the Everglades.

The problem of running four dredges in the Everglades, some 400 miles from Tallahassee, together with the prespect of putting two additional dredges into operation led the drainage board to advertise for bids in 1909 for private contractors to undertake the canal excavations. On June 15, 1910, the drainage board contracted for the excavation of 184 miles of canals, and from this date the majority of the drainage work done in the Everglades Drainage District was done under contract.

The activity of the operations together with the advertising given the board's program attracted the attention of land buyers. Several midwestern capitalists purchased large tracts which they divided and sub-divided for resale to individual purchasers who were attracted through land sales promotions by the original owners. "There are agents at work selling this land in every state of the Union,"[65] wrote Gifford, whose book of essays itself formed a part of the sales promotion of one of the large land companies. The "boom" became so loud and the clamor so great that the Commissioner of Agriculture of the State under the direction of the I. I. Trustees published a statement on the situation. "The Trustees of the Internal Improvement Fund have nothing whatever to do with those companies, know nothing of their plans, methods of selling, or contracting to sell their holdings. Their financial standing must be found through other channels. While we have no cause to doubt their good faith, we cannot endorse or recommend any private enterprise."[66] Winthrop Packard, writing in the March 1910 issue of TECHNICAL WORLD, pictured the rush to purchase Florida lands in the Everglades and estimated that 40% of the sales made were to actual settlers. Readers today are inclined to doubt Packard's estimate as to settlers when he notes the Bolles company had sold some 10,000 farms in ten-acre tracts at prices varying from $20 to $24 an acre; that the Everglades Land Company had sold 2,000 farms at the same prices, the Everglades Plantation Company had sold 1,000 farms at $30 to $50 an acre; and the Everglades Land Sales Company had sold about the same as the Plantation Company. Most of the sales were made, according to Packard, to small speculators who hoped to get an increase in price later on". . . when they come out from under the water."[67]

After the passage in 1907 of an Act amending the 1905 Drainage Law, which set up the actual limits of the Everglades Drainage District and the assessment of a drainage tax of 5c per acre per year, six land companies carried through the Federal courts a suit enjoining the drainage commissioners from collecting the tax. The case was pending in the United States Supreme Court in January 1910. The land companies looking to a settlement, met ex-Governor W. S. Jennings, as attorney for the drainage board, at a conference in Jacksonville in January 1912. W. F. Coachman, J. E. Ingraham, Pearl Wright and George F. Benson represented the land companies. An agreement was reached whereby the suits would be dropped, the drainage taxes for 1907-1912 would be paid by the companies, the contracts for 200 miles of canals in three years would be awarded by the drainage commissioners, and a competent drainage engineer would be hired by the drainage board.[68]

The canal routes adopted in the agreement were the North New River, the South New River-Miami, and a third from a point on the Miami to the Gulf of Mexico. The board hired J. O. Wright of the United States Department of Agriculture as chief drainage engineer.

Early in April 1911, Governor A. W. Gilchrist made a speech to the legislature in which he outlined the progress of Everglades operations. He stated that the state had cut about 16 miles of canals to July 1, 1910, at an overall cost of $218,000; that since that date the private contractors had cut 24 miles of canals to April 1, 1911, and that contracts had been let for 184 miles of canals to be completed by July 1, 1913. As in the case of previous legislatures a joint committee was created to visit

[65] Gifford: EVERGLADES AND OTHER ESSAYS (see page 27—Note 63).

[66] Sen. Doc. 89, p. 119.

[67] Winthrop Packard, RUSH FOR FLORIDA, "Technical World," March 10, 1910, pp. 20-21.

[68] MINUTES OF THE BOARD OF COMMISSIONERS OF THE EVERGLADES DRAINAGE DISTRICT, I, pp. 3, 8-16, 19 (hereafter cited as E.D.D. MINUTES.

the drainage operations and make a report. The committee viewed the canals at coastal and lake ends and reported that they were of the opinion that no land was completely drained nor would be until the canals were finished to the lake and the lake level lowered, though some 15,000 acres adjacent to the outlet of the canals were partially drained. The committee concluded by reporting that it did not believe, ". . . that the canals now being dug will suffice to drain all the Everglades."[69]

In 1911, W. S. Blatchley, a former state geologist of Indiana, made a trip up the Caloosahatchee and into Lake Okeechobee where he saw but three houses on the lake shore. After seeing the dredge working in the lake end of the North New River Canal, Blatchley observed, "When we remember that the lake is only a great saucer 20.5 feet above tide, and that the Kissimmee drains into it, practically in four months of the year, 48 inches of rainfall from 8,000 square miles of territory, we can understand how visionary is the scheme proposed Thousands of dollars have been spent in advertising and millions gotten back in profit by selling to widows, orphans, and poor devils in the North, this land, in five or ten acre tracts at $50 to $100 an acre."[70] As with any project in which there is a question of success, doubt as to Everglades reclamation was expressed from the first. The Everglades drainage operations, giving rise to land selling and high pressure salesmanship with a large amount of speculation, were subjected to a considerable amount of criticism in the press of the nation. Criticism of the methods employed, of the accuracy of surveys, of the estimates of engineers, of the whole practicability of drainage, of the resulting value of the soil, all became questions without immediate answers. The enterprise became a subject of national agitation. A resulting panic among purchasers of lands saw many payments on sales contracts lapse. The consequent failure to obtain funds to vigorously prosecute the work hampered the operations in the Glades. In order to throw information into the arena of public discussion, Senator D. U. Fletcher secured the publication of a large number of Everglades papers and documents in Senate Document 89 of the 62nd Congress.[71] Several dealers in Glades lands were indicted for using the mails to defraud. Accounts of these indictments were published throughout the United States, especially in states from which much money and many settlers had come. The continued criticism resulted in the appointment of the Florida Everglades Engineering Commission in 1913.

In the collected papers of the late Thomas E. Will of Belle Glade, Florida, there is a letter from Herman B. Walker of Ft. Lauderdale, one of the out-of-state settlers who bought land in the Glades on sales contract from the Everglades Land Sales Company. Walker recited some of the grievances of the "pioneers" against the state and the companies: deceptive literature misrepresented old hammock farms for true Everglades land, and the lands were far from drained as had been promised. "The Everglades proposition is experimental, nobody knows what it will do although I believe it will succeed when we learn how to do it. . . . There is not a farm of commercial size . . . anywhere in the Everglades, despite all the lurid literature."[72]

The Internal Improvement Trustees attempted to stem the tide of adverse criticism by appropriating $1,000 to conduct a party of press representatives on a tour of the Glades.[73] The party arrived in Jacksonville on April 12, 1912 and was accompanied on the trip to the Everglades by Governor A. W. Gilchrist and other state officials.[74] The furor did not die down, however, for in September, 1912, the drainage board was forced to accept the resignation of J. O. Wright, chief engineer. Wright stated to the board that he had tried to do the conscientious thing, but that he could not accomplish the desired results and wished to be relieved of his duties.[75]

Further evidence that there was doubt as to whether or not the system of canals as outlined was sufficient to take care of the drainage of the upper Everglades was given in a letter written to Daniel W. Mead, Leonard Metcalf, and Allen Hazen as a

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[69] SENATE JOURNAL, 1911, pp. 1754-1772.

[70] W. S. Blatchley, IN DAYS AGONE: NOTES ON FAUNA AND FLORA OF SUB-TROPICAL FLORIDA IN THEH DAYS WHEN MOST OF ITS AREA WAS A PRIMEVAL WILDERNESS, Indianapolis, Nature Publishing Company, 1932, p. 100.

[71] Rufus E. Rose, THE SWAMP AND OVERFLOWED LANDS OF FLORIDA: THE DISSTON DRAINAGE COMPANY AND THE DISSTON PURCHASE, Tallahassee, Florida, T. J. Appleyard, 1916, pp. 1315.

[72] Herman B. Walker to Thomas E. Will, January 18, 1912. (The writer was allowed the use of the collection through the courtesy of Mr. L. E. Will, Belle Glade.)

[73] INTERNAL IMPROVEMENT FUND MINUTES, IX, 391-395.

[74] JACKSONVILLE EVENING METROPOLIS, April 22, 1912.

[75] INTERNAL IMPROVEMENT FUND MINUTES, IX, 504-505.

board of consulting engineers employed by the Everglades Land Sales Company, in a private investigation in July 1912. V. W. Helms, president of the Everglades Land Sales Company, in this letter directed the engineers to ascertain what amplifications of the state system, if any, would be required to furnish satisfactory drainage.[76]

In their instructions to the consulting engineers the land company asked that the investigators report with special reference to drainage for the company lands. In the letters of transmittal. Mead, Metcalf and Hazen wrote that they found the drainage of the Everglades feasible from both engineering and financial points of view, but were of the opinion that the development must be gradual. "We find the present and projected system of canals, as provided for by the State of Florida, totally inadequate to accomplish the drainage of the Everglades. We are of the opinion that the reclamation of your land can best be accomplished by diking and the construction of pumping stations by which the water may be drained from your lands."[77] These engineers found that to ascertain the amplification which would be necessary would require a large amount of study and investigation, together with extended observations and surveys, and they recommended that further studies be carried out by the State or others interested in the reclamation of the Everglades. The engineers stated that without attempting to analyze the plans of the drainage commissioners or pass on details or to offer suggestions as to Everglades reclamation and how it should be accomplished they felt several definite conclusions could be drawn, to the effect, that:

1. Development was possible from an engineering standpoint and that such would more than repay the necessary costs.
2. Work done and projected in 1912 was entirely inadequate.
3. Canals under construction or projected would possibly benefit the Okeechobee lakeshore but would flood the Everglades.
4. It was inexpedient to attempt reclamation except as lands could be settled.
5. Complete cost of reclamation was prohibitive until the demands for land was greater than in 1912.
6. Future development must depend on total readjustment of transportation, proven experiments, etc.
7. Work must be done in progressive stages.
8. Complete reclamation of the Everglades would require:
    a. Control of the Okeechobee lake levels.
    b. Construction of more numerous drainage canals.
9. All canals must have many times projected capacity with a prism below sea level of full discharge capacity at tidewater outlets.
10. Okeechobee control must be independent of Everglades drainage.
11. Private lands in the Glades would not be drained by work under way or projected by the State.
12. Drainage of private lands, to be effective, must be done by owners.
13. A comprehensive study must precede effective Glades reclamation.
14. A sound drainage act was essential to successful reclamation of the area.

Mead, Metcalf and Hazen made it quite plain that under the State plans for reclamation of the Everglades no formal notice had ever been given that these lands would be drained, but that it appeared the Trustees had been led to hope the plan might be sufficient and that the public quite generally assumed this to be the case. The engineers found it inconceivable that some 20,000 land buyers would have bought had they not presumed such to be the case. They found that J. O. Wright in his 1909 report did not use available United States Weather Bureau Statistics, that Wright's evaporation statistics were inapplicable under Florida flood conditions, and that his conclusions were unwarranted in the contemplated eight canals either by the data discussed or any other. The report held that agricultural development in ten acre tracts was impractical and that the bulk of the Everglades must be developed in

[76] Mead, Metcalf and Hazen Report (MSS), 1912, (through the courtesy of Mr. F. C. Elliott, Secretary of the Internal Improvement Fund the writer was able to inspect a copy of this report in the Tallahassee office of the secretary.)

[77] *ibid.*, pp. 11-12.

large tracts for orchards, sugar cane or other produce for which the lands might be adaptable. Such agricultural developments would have to be accompanied by canning, sugar and other factories as well as the facilities entailed by population growth, which under best conditions must be slow.[78] In regard to lands of the company the engineers held that only by a combination of gravity flow and pumping would these lands be rendered arable. They further warned against dangers of over drainage and possible fires in the highly inflammable muck. In regard to subsidence, they estimated that the soil would shrink from 30 to 50 per cent of its depth and that continued cultivation might probably result in further compaction. In 13 appendices the board included a mass of tables, rainfall statistics, trip notes, maps, graphs and material on runoff and pumping equipment from the United States Department of Agriculture.

Since the Mead, Metcalf and Hazen report was made for a private corporation and not available for publication the facts that it contained did not ever reach the public. It is certain, however, that even a private report could not be kept completely out of circulation. By April 1913 the demand for a public engineering investigation reached realization when the Trustees of the Internal Improvement Fund and the Board of Drainage Commissioners contracted with Isham Randolph to organize a board of engineers to be known as the Everglades Engineering Commission consisting of Randolph as chairman, Marshall O. Leighton and Edmund T. Perkins. On April 30 the board agreed with these engineers to make a complete and comprehensive investigation of the area, and of the best methods to drain, together with the specifications for canals and total costs. The finished report was turned over to the Trustees of the Internal Improvement Fund on October 25, 1913, and was printed as United States Senate Document 379, 63rd Congress, 2nd session, after having been submitted for this purpose by Senator D. U. Fletcher of Florida.

The 1913 engineering commission concluded that the drainage of the Everglades was entirely practicable and could be accomplished at a cost which the reclaimed land would well justify. The solution of the Everglades drainage was found to be dependent on the disposition of waters entering Lake Okeechobee from the north. "In our judgment the Everglades can best be relieved of this servitude by diverting the flood waters through a canal of adequate capacity occupying the shortest practicable route to the Atlantic Ocean or an outlet thereof."[79] With the Okeechobee flood waters diverted, the problem of draining the Everglades would then be reduced to the proper provisions for carrying off the precipitation upon the Glades by adding to the main canals traversing the territory. It was recommended that the cost of the St. Lucie Canal be charged against: 1. Control of Okeechobee's level for land drainage and flood storage; 2. 12 foot navigable channel and 3. Water power of primary capacity of 5,000 horsepower. The commission estimated the total cost of this canal, lock system and power plant at $2,500,000.

"We have encountered the idea," the commission reported, "which if not generally prevailing, is, at least entertained by a large number of intelligent citizens of Florida to the effect that the problem of draining the Everglades cannot be solved by progressive steps. . . ."[80] This view the engineers held to be erroneous in that the drainage work could proceed only as fast as there was need for those areas as homesteads or for useful production. The commission noted that the system of canals—North New River, South New River, Miami, Cypress Creek, Snake Creek, Snapper Creek, Hillsboro, and West Palm Beach—dug or contracted for, contemplated the reclamation of a greater portion of the Everglades in the immediate future than would probably be justified by the demand for new lands. "It would have been much better to provide for an orderly progression of reclamation in accordance with the demand and with due regard to market conditions and transportation facilities. The existing works and the conditions of land ownership and settlement, seems now to be such as to necessitate an earnest effort to reclaim in one continuous project and with the greatest possible expedition all the lands south and southeast of Lake Okeechobee between the Miami Canal, the proposed West Palm Beach Canal and the eastern boundary of the drainage district."[81]

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[78] Mead, Metcalf & Hazen Report, pp. 88-91.

[79] EVERGLADES ENGINEERING COMMISSION REPORT, SENATE DOCUMENT 379, 63rd Congress, 2nd Session, p. 5 (1913)

[80] *ibid.*, p. 7.

[81] *ibid.*, p. 12.

The proposals of the 1913 commission were:

1. Canal between West Palm Beach and Hillsboro Canals leading into the Hillsboro Canal.
2. Canal between North New River and Hillsboro Canals leading into the Cypress Creek Canal.
3. Canal between North New River and Miami Canals leading into the Snake Creek Canal.
4. Enlarge Snake Creek Canal.
5. Enlarge Cypress Creek Canal.
6. Allapattah flats canal into St. Lucie.
7. Indian Prairie—Fisheating Creek Canal.
8. Thirteen other canals of a smaller size between larger main canals.

The report of the Randolph Commission was all-inclusive and planned for the complete drainage of the Everglades in the areas as noted above. It was unfortunate that 1913 was a dry year in that many observations made by the commission were based on low water. Had 1913 been a very wet year, the report would in all probability have made allowances for larger flood stages than will be found in the document. The water power suggestion was the most questionable aspect of the report in view of the fact that Lake Okeechobee had never reached an eleven foot stage within the memory of men to that time and it was supposed that the Kissimmee River would supply a steady and continuous flood for waterpower use.

In the spring of 1913 the commissioners called a meeting in Tallahassee to consider ways and means for financing future Everglades reclamation. Among those present were Pearl Wright, Edgar Stearn, and George F. Bensel representing Southern States Land and Timber Company, W. F. Coachman and D. R. McNeil representing Consolidated Land Company, Sidney Harrison of the Model Land Company and Florida East Coast Railroad, ex-Governor W. S. Jennings representing V. M. Helm of the Everglades Land Sales and associated companies, and J. E. L'Engle representing both Consolidated and Southern States Land and Timber Companies. The Trustees suggested the division of the Everglades district into zones, with lands in the zones to be assessed in accordance with the proximity to canals and other works. The questions of zones, assessments, a new drainage district, and bond issues were discussed at length. It was agreed that the counsel for the board should draw up a new bill for the proposed district, the zoning of lands, and a $6,000,000 bond issue.[82]

In his first message to the 1913 legislature Governor Park Trammell stated that there had been marked progress in the Glades, but that the enterprise had been embarrassed financially. The governor recommended a bill to allow the Trustees of the Internal Improvement Fund to set up one or more experimental farms which would add materially to the development of the state and enhance the value of all lands in the area. He also asked for a bill to provide for the establishment of local drainage districts to enable private land owners to cooperate with the state program. About the same time the annual statement was posted showing the progress of the drainage program. To April 1, 1913, there had been spent $2,152,770 completing 142 miles of canal and 2 locks.[83]

The 1913 legislature passed laws enabling the drainage commissioners of the Everglades Drainage District to bond lands in the district and an act providing for the creation of local drainage districts. In July of 1914 the commissioners offered the first bonds for sale, but withdrew the offer in August on account of the unsettled conditions of the money market. On January 1, 1917, Spitzer, Rorick and Company of Toledo, Ohio, bought the first issue of $3,500,000.[84]

Scattered references from travelers, botanists and others to settlers on the Everglades borders or the shores of Lake Okeechobee can be found, but there was no real settlement in the Everglades until after the end of the first decade of the 20th century. Even after that date there are few records available of the common, everyday happenings, due in large measure to the floods and storms of the 1920s which destroyed such as there had been. One pioneer who entered the Everglades in 1914 later wrote down many of his memories of the "early days." John Newhouse (Jan

[82] INTERNAL IMPROVEMENT FUND MINUTES, X (April 21, 1913), pp. 138-142.
[83] HOUSE OF REPRESENTATIVES JOURNAL, 1913, pp. 1153-1156.
[84] E.D.D. MINUTES, II, pp. 63, 243; III, 1-8, 76-90.

Van Nyhuis), an emigrant from the Netherlands, entered the Glades by way of South Dakota. He settled, with several others, at the crossing of the Bolles and North New River canals, five miles south of Okeechobee's shore. "There were two shanties on the mouth of the North New River Canal, and here and there along the south lake shore the buildings of some pioneers could be seen." Bolles Hotel at Ritta and Forbes Hotel on Ritta Island were the only lodging places in the Upper Glades. According to Newhouse the real estate propagandist said: "Take a tent, a bag of beans, and a hoe; clear a few rows in the sawgrass, plant the seeds and you will have an income. . . . That may have provided an income for the land offices, but the settlers found out differently."[85] The difficulties of these pioneers included the boating of supplies from Ft. Lauderdale fifty miles up the North New River Canal, the lack of skilled labor and the pests of mosquitos, snakes and 'gators. The land was cleared by hand, taking one man two months to clear an acre. Once cleared and seeded, the pioneers found that the plants grew wonderfully on the raw sawgrass muck and then for unexplained reasons would wilt and die. The settlers called it

Figure 1.—Early transportation in the Everglades. The "New Okeelanta" of Okeelanta operating up and down North New River Canal between Ft. Lauderdale and the lake region settlements.

Photo by John Newhouse, 1920.

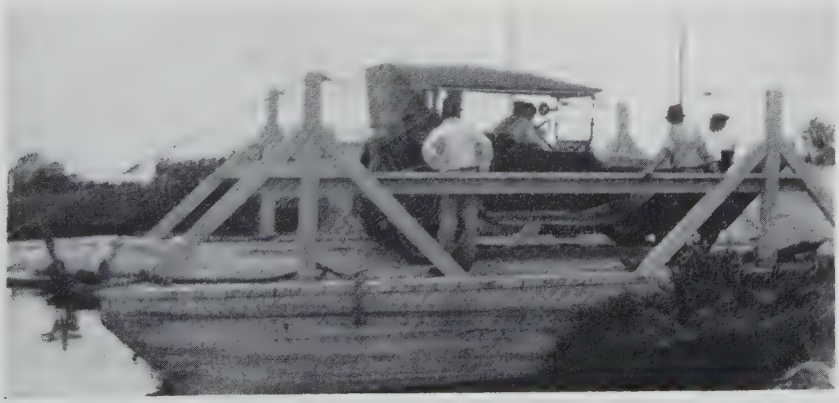

Figure 2.—A "Model T" indulging the ferry at Okeelanta in 1920.
Photo by John Newhouse, 1920.

[85] John Newhouses: "MEMORIES OF EARLY DAYS IN THE GLADES" (MSS), I, p. 8. (Through the kindness of Mr. Newhouse the writer was able to use his memoirs for this history.)

Figure 3.—Side view of one of the great "Buckeye" ditchers that dug a broad, well formed channel the shape of the scoop pans on the large wheel, all at one passage.
Photo by John Newhouse, 1920.

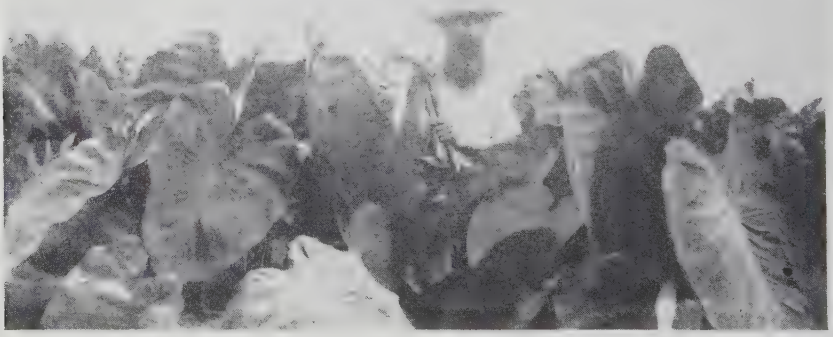

Figure 4.—Dasheens in the Upper Glades. This was one of the plants which grew so wonderfully well in the early days and perhaps led the settlers of that time to expect much more from the land than the conditions of water control then available could possibly justify.

Photo by John Newhouse, 1920.

"the reclaiming disease." Setbacks from frost, soil troubles and plant diseases dulled the optimism of many of the settlers and they left, but others came in to take their places. Newhouse told of Gladescrest, at the interestcion of Hillsboro and Bolles canals, a community of 200 in 1914, which disappeared. But other hardy settlers stuck it out and by varying their crops of beans, potatoes, cabbage, lettuce and others, managed to live. Continued cultivation over a period of years rendered the land arable and the pioneers learned slowly how to farm the heavier type of muck lands, adjacent to Lake Okeechobee.

By 1917 the development of a townsite at the Okeechobee entrance of the Caloosahatchee canal saw the beginning of Moore Haven. In a period of low water in the late 'teens squatters settled on the lake shore with intentions of homesteading, but in a year or two high water forced them off and several settled at the intersecion of the North New River and Hillsboro canals, near the site of Belle Glade. By 1921 there were 16 settlements on or near Lake Okeechobee with an estimated total population of 2,000. In 1917 J. W. Conners bought a section of land on the West Palm Beach canal and inaugurated some small truck farms, and when this project failed

he started dairying operations, but these failed too and in 1923 Conners shifted his operations to highway building. The Conners Highway was projected to run from Okeechobee City to West Palm Beach, along the lake shore and the West Palm Beach Canal. The Upper Everglades settlements existed, if they did not exactly prosper, from 1914 to 1922. The prospects of making a good crop on the rich muck land brought many new settlers into the region. Water control had been a matter of concern up to 1922, but after that date floods and storms were a matter of life and death, especially in 1926 and 1928.

Under the auspices of the United States Department of Agriculture a soil survey was made in 1915 of a strip 2½ miles on each side of the North New River Canal from Ft. Lauderdale to Okeechobee. This survey, conducted by Mark Baldwin, H. W. Hawker and Carl Miller, was realistic and not too complimentary to the area surveyed. The report cited the amount of work necessary to prepare the muck in order to make it arable, the inadequate facilities for drainage and irrigation, the non-utilization of other large muck and peat areas, the high prices of Everglades lands based on unknown production abilities, and the dangers of frosts to winter

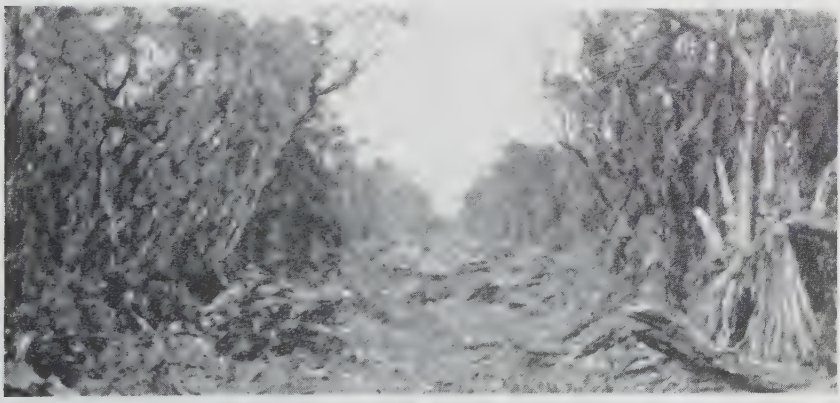

Figure 5.—An excellent view through the typical custard apple and other dense growth that occupied the narrow belt of so-called "Custard Apple Land" about the southern and eastern shores of Lake Okeechobee in the early days.
Photo by John Newhouse, 1920.

Figure 6.—Dense growth of elderberry and other low shrubs occupying an intermediate zone between the forested custard apple zone shown in Figure 5 and the open sawgress land shown in Figures 7 and 8.
Photo by John Newhouse, 1920.

Figure 7.—Typical sawgrass in bloom. This is the heavy sedge of which the brown fibrous peat of the open glades is composed for the most part.
Photo by John Newhouse, 1920.

Figure 8.—A general view of an Everglades fire from a position along one of the main arterial canals.
Photo by John Newhouse, 1920.

vegetable crops. The report concluded: "It is such land as this, untried for agriculture and a large proportion of it under water, that . . . is being sold for $20 to $65 an acre."[86] Needless to say the report of the soil survey was quite unpopular and was soon hushed into disappearance. John Newhouse wrote that he was never able to obtain a copy, and Mr. Lawrence Will of Belle Glade informed the writer that all available copies were destroyed in a public fire in Ft. Lauderdale soon after it appeared.

By 1918 two railroads had reached Okeechobee's shores. The Florida East Coast had completed a branch from New Smyrna to Okeechobee City in 1915. The Atlantic Coast Line reached Moore Haven from Haines City in 1918. When J. J. O'Brien and A. C. Clewis began their development at Sand Point, later called Clewiston, they built the Moore Haven and Clewiston railroad, which was later incorporated into the Atlantic Coast Line. The Florida East Coast extended its lines around the east side of the lake and by 1928 the two railroads met at Lake Harbor (Miami Canal). The East Coast line secured an option on the bank of the North New River canal to extend its line into Miami, but the option was allowed to lapse. Prior to the build-

[86] Mark Baldwin, H. W. Hawker, and Carl Miller, SOIL SURVEY OF THE FORT LAUDERDALE AREA, FLORIDA, United States Department of Agriculture, Washington, D. C., 1915, p. 40.

ing of the railroads, boats were the only means of transportation or communication. With the opening of the North New River Canal in 1912 boats from Ft. Lauderdale were added to the existing boat lines through the Caloosahatchee to Ft. Myers. Mail boats, carrying freight and passengers as well as mail, made regular trips around the lake shore, later using the West Palm Beach Canal to the east coast. Highways, though planned to be of macadam, were at first merely raised ridges of muck that often burned up in extremely dry weather. Travel was slow and uncertain, especially in wet weather and very dusty in dry weather. One traveler wrote that he was unable to tell his fellow white man from a black one after a few miles on the muck roads of the early days. Conners opened his lakeshore-to-coast highway in 1924 and though it never repaid its initial investment, traffic was heavy in the years preceding the collapse of the 1926 land boom.

In 1917 Sidney J. Catts was elected governor of Florida and soon became the center of a battle of "to bond or not to bond." In making a speech in January of 1917 he said. "One trouble about the matter is that the people living in other sections of the state are not in sympathy with the drainage of the Everglades as they should be."[87] The Governor stated that he would attempt to float the first bond issue and then another equal amount. ". . . which should put the whole section largely in condition of cultivation. . . ." When the legislature met in April 1917 the Governor was so tired of the bond battle that he asked the august body to put the million and a half acres then in the Internal Improvement Fund on the market for sale at $5 and $8 an acre to pay off the debts of the drainage board and turn any remainder over to the school fund, allowing Everglades drainage to pass into private hands. The question was finally settled by the selling of the first bond issue and the creation of the N. B. Broward drainage district within the Everglades Drainage District to give especial care to lands in the Fort Lauderdale area of the Glades.

Interest in the use of Glades land for sugar cane production came to a definite focus in the last years of the World War I. Sugar cane had been grown in the Glades by the Indians long before drainage was thought of. Many of the settlers prior to 1920 had plots of cane for their own use. In 1919, 60 acres of cane were grown at Pelican Bay on the lake shore and the crop was shipped to a Jacksonville syrup mill. Judge John C. Gamling of Miami put in 125 acres of cane on the southeast lake shore, but gave up because of lack of water control. In 1919 the Pennsylvania Sugar Company began planting on a thousand acres 16 miles northwest of Miami on the Miami Canal. The company later erected a 1,500 ton sugar mill on the plantation, but due to soil deficiencies, satisfactory yields were not obtained and this together with the lack of adequate water control caused the operations to cease. The mill later became the nucleus for the present Clewiston sugar house.[88] About the same time sugar operations began at Canal Point under the direction of F. E. Bryant and others. These latter operations were successful and were later combined with the B. G. Dahlberg sugar interests to form the Southern Sugar Company which in turn gave way to the present United States Sugar Corporation. In 1921 the United States Department of Agriculture established a cane breeding station at Canal Point, selected because of nearness to Lake Okeechobee and because of little danger of frost. At the time of its establishment, this station was further north than any other cane breeding station in the world.

1922 was a black year for the Everglades. The rainfall for the nine months ending September 30th was reported to be more than 10 inches in excess of the annual average for the entire year. The towns of Bare Beach, Okeelanta and Clewiston were all under water and southwest of Moore Haven was a body of water a half mile wide and 40 miles long.[89]

The 1921 legislature provided for the establishment of an agricultural experiment station for the Everglades area with joint aid from the Trustees of the Internal Improvement Fund and the State. The work of this station, as referred to elsewhere in this brief report, subsequently proved of very great importance in the agricultural development of the Everglades. This included not only the discovery of the vital importance of the so-called trace elements copper, manganese, zinc and boron in the successful handling of these organic soils (before and after burning), but also the important and closely related problems, from the crop production standpoint, of

[87] FT. LAUDERDALE SENTINEL, January 5, 1917.

[88] F. D. Stevens, "HISTORY OF FLORIDA SUGAR OPERATIONS," (MSS), p. 20.

[89] FLORIDA-TIMES UNION, October 5, 1922.

soil and water conservation, general fertility requirements, plant adaptability by selection and breeding, plant disease and insect control, etc., etc.

Despite conditions of high water or of low water the lake shore sections of the Everglades grew, if they did not become prosperous. Estimates of the 1924 crop values and acreage varied from $1,000,000 and two thousand acres to $4,000,000 and ten thousand acres. Tomatoes, beans, peas, peppers and potatoes made up the bulk of the crops. "During the last three years progress has been great. Scores of truck farms have sprung up on the reclaimed lands. The reclaimed section around the southern end of Lake Okeechobee shipped $4,000,000 worth of vegetable products. A little branch line railroad shipped 1,200 carloads of products for the north."[90]

The early 1920's found Florida enjoying one of her periodic land booms. The Everglades area enjoyed the boom of the twenties as it had the boom of the early teens. Private enterprise built such roads as the Conner's Highway, the Florida East Coast extension to Lake Harbor, and the Seaboard Air Line extension to Miami. Sub-drainage districts installed pumping units. The B. G. Dahlberg interests were developing sugar mill and cane planting operations along the lake shore. John W. Martin, governor beginning in 1925, in his first message to the legislature announced that the state was definitely committed to reclamation—that there could be no turning back. The high waters of 1922-23 receded and in 1926 dry weather through the winter witnessed an unprecedented series of grass and muck fires. Spring rains put out the muck fires and Okeechobee's level rose again. In the third week of September a tropical hurricane blew the water out of the southwest end of Lake Okeechobee, leaving 327 dead. Moore Haven had been flooded in 1922 and becoming lower through subsidence than the normal lake level, had built dikes of muck, dikes that melted before the wind-driven waters.

The Moore Haven disaster awoke the people of Florida at large to the fact that the valuable Everglades area was a hodge-podge attempt at drainage. Probably no one had more to do with bringing this fact to public attention than Governor Martin. Although abuse became his lot and rumor marked his step, Martin had a plan. The governor took his stand on the 1913 Randolph plan and defended his predecessors. The reaction in the Everglades was, in part, expressed by the "EVERGLADES NEWS" which charged the governor and his board with draining nothing but the treasury. Governor Martin and the drainage board called a conference on the Everglades at Tallahassee to which a number of leaders were invited. Among other things this conference adopted resolutions seeking an enlargement of the Everglades Drainage District, wider taxation in the district, a state-wide one-half mill levy, an advisory committee of five to work with the board, the establishment of drainage headquarters with a resident engineer in the Everglades, and an engineering board of review.[91]

Governor Martin prepared for the 1927 session of the legislature with two lengthy reports. The first of these was the Biennial Report of the Chief Engineer of the District for 1925-27. F. C. Elliott, Chief Engineer, presented the board with a bulletin containing the status of the drainage work to 1927: canals, levees, locks, money expended and proposals for new construction. The total drainage expense of operations and maintenance to 1924 was set at $14,903,854. The estimates of money to be expended on new canals was $13,704,515 and work remaining on old canals was set at $5,022,825. The area included in the estimates may be stated in general terms as that part of the district north and east of the Miami Canal and a belt around Lake Okeechobee. The chief engineer further recommended that steps be taken at once to prevent a repetition of the 1926 storm disaster by building a levee on the southern shores of the lake. He advocated the cutting of new canals on an east-west basis as against the diagonal plan of the Randolph report, due to east-west canals' following the shortest route to the ocean and taking advantage of easier excavation along those lines. The total estimate of cost for new canals, existing canals, control works and Okeechobee levee was $20,583,438 The proposed work, the engineer noted, should be carried out in blocks allowing 8 years for final completion of the main drainage works to drain 2,300,000 acres. The valuation of property in the Everglades drainage district was set at $52,404,416 in 1926, with taxes assessed at $1,636,490.98. Total bonds outstanding as of January 1, 1927 were $10,255,000, with $497,862.23 owing for construction and $298,000 due the Trustees of the Internal Improvement Fund.

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[90] CHRISTIAN SCIENCE MONITOR, January 11, 1924; EVERGLADES NEWS, March 21, 1924.

[91] E.D.D. MINUTES, VI, pp. 201-254.

On March 22, 1927, the board made an agreement with three engineers: George B. Hills, a consulting engineer and secretary of the 1913 Isham Randolph Commission; S. H. McCrory, Chief of the Division of Drainage Investigations, Bureau of Public Roads, United States Department of Agriculture; and Anson Marston, of the College of Engineering of Iowa A. & M., to serve as the 1927 Everglades Engineering Board of Review.

The Board of Commissioners of the Everglades Drainage District, in directions given the Engineering Board of Review, instructed them to review fully the plans of the 1913 Randolph Commission, to check carefully to find if the 1913 plans had been followed, if the 1913 plan was the proper one to follow, to report on the correctness of the work already done. They were further instructed to make recommendations for the future, investigate the economy with which previous work had been done, decide whether to drain as a whole or by units, and finally, to give all information which might aid the Board in the reclamation of the Glades. "The interview and our conference with you prescribed that our work was to . . . (confine) . . . its attention to the engineering features of the Everglades drainage."[92]

After two weeks' inspection of the Everglades the Board spent several weeks in Tallahassee examining a mass of records and data collected there by the staff of the Everglades Drainage District. The Board recommended that a 1927 revised plan for drainage be adopted embodying three essential features:

1. Control of Lake Okeechobee.
2. A system of main drainage canals.
3. Progressive drainage by unit areas.

The recommendations of the Board in regard to Lake Okeechobee control included outlet canal flow of 7,500 cu. feet per second and ultimate outlet flow of 10,000 cubic feet per second, an enlarged levee of 27 feet sea level elevation on the southeast to southwest shores of the lake and provision for pumping stations to relieve the difference caused by subsidence of the muck. The Board further recommended levees to maintain drainage along the canals at least 4 feet above ordinary high water level and a supplemental system of 18 east-west drainage canals to provide main canal drainage in addition to the diagonal system as it existed in 1927. The Board estimated the total cost of these improvements to be $22,711,630. With the necessary control works for the canals and a levee on the west bank of the Miami canal to keep out water from the west, the total estimate came to $25,288,070.

The Board of Review suggested that the drainage be carried out in successive sections insofar as conditions of settlement and development would permit. The board found that the 1913 Randolph plan was being carried out in general, that $14,903,854 had been spent on all operations to 1927, and the work had been done with praiseworthy economy. "The existing Everglades drainage works have removed the year-round standing water from vast areas of land, have brought Lake Okeechobee to the point where its levels can be successfully controlled in most years, have brought a considerable number of settlers into the Everglades Drainage District, have interested capital for agricultural developments on large tracts whenever adequate drainage can be assured."[93]

In its conclusions the Everglades Engineering Board of Review noted that the 1913 Randolph plan had stated that the progressive plan was preferable, but that the Randolph plan also sought to reclaim the areas south and southeast of Okeechobee between the West Palm Beach and Miami Canals. The Everglades Engineering Board of Review concluded, "Actual experience since 1913 in carrying out this policy has demonstrated that very much greater areas of Everglades land would have been brought into use by 1927 if money available for main canal construction from year to year had been spent in close accordance with a wise progressive plan."[94] The Board finally concluded that provisions for 8 inch subsidence in the Randolph plan were offset by actual 3-4 foot shrinkage on the Okeechobee shore since 1913, and that provisions should be made for further reasonable subsidence in the ten years after 1927.

A month before the Everglades Engineering Board of Review handed its report to the Drainage Board, Governor Martin presented his plan for a twenty million

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[92] REPORT OF THE EVERGLADES ENGINEERING BOARD OF REVIEW, pp. 2-3 (1927).

[93] EVERGLADES ENGINEERING BOARD OF REVIEW REPORT, p. 45.

[94] *ibid.*, p. 48.

dollar bond issue to the state legislature. In his special message to the legislative body he noted that the great trouble since 1903 had been the lack of sufficient money in each administration. It had not been that the Glades could not be drained or that the soil was unproductive. The Governor stated that he could float the proposed issue, which would enable the drainage operations to continue and put the Glades on a sound basis. The 1927 legislature authorized the Martin bond plan. The bonds were ordered sold by the Drainage Board, but litigation in the courts prevented the delivery of the bonds and none of them were ever sold. By June of 1927 the Drainage Board found itself without funds and ordered all new construction work to stop. Until July 1928 certain works were continued and maintenance carried on. However, little work has been done in the drainage district by state agencies since 1928.

The Martin bond plan became an issue in the press and in discussions throughout the state. While many leaders in business, politics, and press supported Martin's plan, there were likewise many who opposed it. The whole state of Florida, especially the more southern parts, had experienced a land boom in the early 1920's which had been accompanied by a great deal of county and municipal bonding. The collapse of the boom in the fall of 1926 had left bitter memories in the minds of some and grave doubt in others. When the Everglades Drainage District had been created in 1907 and amended in 1913, it included an area just to the west of Miami. In this Miami area there had since developed metropolitan suburbs and as the Martin bond issue act provided for ad valorem taxes, if needed, it was quite natural that this area would oppose the bond issue on the tax basis alone. Part of this Miami area in question was included in the Dade Drainage District, a sub-district in the Everglades Drainage District. In the late summer of 1927 the supervisors of this sub-district secured the services of the Dayton Morgan Engineering Company to advise the Board on problems of their bailiwick.

On October 3, 1927, the Dayton Morgan Company sent its report, with a letter of transmittal, to the Sub-district Board. "In advising your Board on the problems of the Dade Drainage District it is necessary to consider the plans and policies of the Everglades Drainage District, because success for the Dade Drainage District is dependent, in a large measure, upon the adoption of an intelligent and adequate policy for the Everglades as a whole."[95] In this report it was noted that the success of the Everglades project depended as a whole and in various parts on four conditions:

1. Modern, well-designed legislation.
2. Thorough and effective engineering design.
3. Adequate financing.
4. The problem resolved to practical reclamation and develoment rather than a political matter.

". . . if other conditions are met, satisfactory financing will follow, almost as a matter of course. If the money is hard to secure or unsual terms must be offered, it is almost conclusive that the development is unsound, or that its management is bad." Morgan prefaced his remarks by noting that any reclamation project must be based on sound legislation. The laws of the Everglades Drainage District, ". . . are about the most primitive, unfair and inadequate of all the reclamation laws in America," and the system of assessments apportioned against the land in the Everglades Drainage District were, ". . . an inequitable, antiquated system arbitrarily fixed by the Legislature. . . .the Everglades project, partly because of poor laws, almost entirely lacking in sound, effective policies has not been accidental or necessary but a natural and inevitable outcome of bad laws and bad policies."[96] As a specific example, Morgan noted that while the Everglades Engineering Board of Review was at work, the legislature was laying assessments on the area west of the Miami Canal, which the board proceeded to levy off swamp for indefinite abandonment, and thus such an area would have borne assessments throughout the life of the bonds.

According to Morgan, the Randolph report erred fundamentally in its conclusions that drainage could be had at a small cost per acre, in figures for navigation, in power development, in the size of a control canal and in the recommendation of the expeditous construction of the long diagonal canals. The Randolph report was largely silent on main issues of economic, financial and administrative policies upon

[95] Dayton Morgan Engineering Company, REPORT TO THE BOARD OF SUPERVISORS OF DADE DRAINAGE DISTRICT ON THE RECLAMATION OF THE EVERGLADES, p. 3 (1927).

[96] *ibid.*, p. 11.

which the success of the Everglades Drainage District depended. The Everglades Engineering Board of Review in its report made no mention worthy of the name in regard to legal machinery, organization, or engineering management. Morgan pointed to the instructions given to the 1927 board and reported that he had questioned the personnel of the Board of Review as to why they did not enter into and advise on matters of policy. The Board replied that Governor Martin confined them to engineering matters as, "He said he considered engineers incompetent to pass on matters of policy. They should confine their attention to the surveys, he said, and he would determine policies."[97] In commenting on this Morgan wrote, "A thorough consideration of the economic features must necessarily have great effect on the design of engineering features, thus in failing to face the main controlling issues the Engineering Board of Review has failed to lift the project from the tangle of legislative, financial and administrative difficulties which have long impeded its progress." Both the 1913 and 1927 engineering reports suggested progressive drainage as the best plan, but Morgan said that, ". . . . at the same time (they were) recommending a system of canals for millions of acres to be immediately constructed at the expense of the entire district." There were, according to Morgan, many excellent features in the 1927 report that should not be minimized because it represented much faithful study of engineering data and was a very great improvement over the 1913 report.

Morgan concluded his report with some suggestions for a sound and effective Everglades project: divorce from the state administration, home rule for the district, public review of plans and efficient over-all plans for future progress. "At some time the Everglades Drainage District will have to recognize and liquidate past management. We believe it is better to do so now than when another ten or twenty million dollars has been committed."[98] Morgan forcast that the district might cease functioning as a government unit, but that Everglades reclamation would go on, "Present agricultural operations in the district clearly demonstrate the desirability of reclamation. The character of the soil and the climate afford an attractive prospect, and some owners will continue to develop their holdings as best they can under any conditions that may prevail."[99] With well worked-out administrative, economic and financial policies the Everglades, wrote Morgan, may become one of the chief economic resources of the state, but ". . . unless the whole project is directed by a quality of management and statemenship that is not yet in evidence, the troubles of the Everglades have only begun."[100] *

With the construction of new drainage works brought to a stop in June 1927, the work of the district from that point was mainly maintenance. Meeting in July 1928, in joint session, the Trustees of the Internal Improvement Fund and the Commissioners of the Everglades Drainage District resolved to cut even clerical expenses to the minimum and did so, making Mr. F. C. Elliott not only Chief Engineer of the Everglades Drainage District but also Secretary of the Board.

In September 1928 a second hurricane whipped the waters of Lake Okeechobee from the lake onto the shore and spread death over the area. At least 1,800 persons were drowned in this sad tragedy which shocked the whole nation, for only in the Galveston flood in the early part of the century is a greater catastrophe to be found. In April preceding the storm the Chief of Engineers of the United States Army had recommended the cutting of a channel from the western edge of the drainge district through the Caloosahatchee River to a depth of 6 feet and a width of 80 feet to provide an additional 2,500 cubic feet per second discharge from Okeechobee. The

*We now know, of course, that those expansive plans of the early days, by whomever developed or promoted at the time, were then and are now entirely impractical from the economic standpoint due to the great variability of the soil and the absolute unfitness of great sections of the Everglades for agricultural development, to say nothing of the paramount importance of developing it by economic units, as needed. These physical relationships are only now in process of systematic study by the modern survey that is under way, as discussed very fully in the proper sections of the symposium that follows, a study that is certain to have a profound influence on the plans for the area that are developed in the future—that is, if proper use is made of this information. Ed.

[97] *ibid.*, p. 11.
[98] *ibid.*, p. 23.
[99] *ibid.*, p. 23.
[100] *ibid.*, p. 24.

Army Engineers' recommendation came as a result of a survey ordered by the Army in 1917, but not authorized by Congress until 1927.[101]

With the advent of the Carlton administration in 1929, the Chief Engineer of the Everglades Drainage District filed his biennial report for 1927-1928. Governor Doyle Carlton had been elected on a platform which in part promised home rule to the Everglades and to put the Everglades on a "pay as you go" basis. It became increasingly obvious that the old order which had prevailed in the Everglades drainage operations would change when Carlton won the governorship. To this end the Chief Engineer summarized the work and accomplishments of the drainage district since its inception. To January 1929 he showed that $14.871,185 had been spent for canal excavation, $2.005.157 for canal control work. $691.434 for levees, and $358,325 for other expenses, a total of $17.926,103. The 1929 report called attention to that of two years previous issued by the same officer which had placed a definite emphasis on the need for lakeshore levees. In the 1929 report the Chief Engineer again demanded levee construction as imperative to the protection of human life in the lakeshore areas. Other suggestions included increased discharge outlets, for lake control, in the St. Lucie or Caloosahatchee canals. The report recommended that a sum of $4.000,000 be raised to be spent at a rate of $1.000.000 per year for the drainage of limited areas. At the end of 1928 there were bonds outstanding to the amount of $10.141,000. The assessed value of the drainage district was set at $106,000,000 as of December 1927. In the period covered by the report the prices paid for state lands in the district averaged from $68 to $92 per acre. The estimated population of the district was set at 48.000. paved roads at 586 miles, railroads at 210 miles.[102]

The Chief Engineer estimated the land values in the Everglades Drainage District in 1905. based on average prices of state lands sold, at $5,391.000; on the same basis in 1927, land values came to approximately $300,000,000. With the total cost of drainage to 1929 figured at $18.000,000. it was possible to see that for each million dollars spent for operations in the district the land and other property values in the district had increased over sixteen times. The Chief Engineer gave emphasis to the fact that other than paying taxes on its lands and contributing some of the proceeds from the sale of lands granted to the state in 1850, the State of Florida had never given any money to the drainage work.

In his efforts to fulfill his campaign pledges Governor Calton secured the passage of an Everglades Drainage District bill giving the board of commissioners ten members, the five state officials as before and five new members to be appointed from residents of the various counties of the districts. The 1929 act provided for cooperation between the district and the United States in regard to flood control. Also in the bill was introduced the "development unit" idea by which 30 per cent of the landowners in any section might petition to develop their section, and proceed to do so under district supervision unless 50 per cent of the remaining landowners voted the proposal down. Other features of the new act provided for annual audits to be made public and new assessment rates. A second act secured by Governor Carlton created the Okeechobee Flood Control District, in large part overlapping the drainage district, a corporate agent of the state to supervise water control over most of the southern end of the state. The governing board of this new district was to consist of the same state officials as served on the drainage district board and five landowners of the district to be appointed by the governor. The Flood Control District was authorized to construct control works and to cooperate with the United States Government, to tax for benefits secured by the district and to bond up to $5,000.000 should the need arise.

As mentioned above, the Chief of Engineers of the United States Army had recommended a canal-channel construction for the Caloosahatchee Canal and River. After the 1928 hurricane disaster. the Army engineers reviewed the previous reports on the Okeechobee-Caloosahatchee drainage area. The subsequent report of the engineers found in Senate Document 213, 70th Congress, 2nd Session. February 1929. made recommendations for the following: an 80 ft.x 6 ft. channel in the Calossahatche canal and river, a 60 ft. x 6 ft. channel in Taylor Creek at the northern end of Lake Okeechobee, and north and south shore levees for the Okeechobee shores at a total cost of $10.715,000. The Army engineers recommended that the State of Florida or other local interests furnish $6,740,000 and the United States, $4,000,000

[101] HOUSE OF REPRESENTATIVES DOCUMENT 215, 70th Congress, 1st Session, p. 5.

[102] F. C. Elliott, BIENNIAL REPORT OF THE CHIEF ENGINEER OF THE EVERGLADES DRAINAGE DISTRICT, 1927-1928, p. 76.

with the state or other local interests to maintain all of the works except the Callosahatchee unit.

In conjunction with surveys made by the flood control project in the late 1920's, a report on the agricultural possibilities of the Everglades was submitted to the Chief of Engineers of the Army. This report, written by E. R. Lloyd, sometime director of the Mississippi Agricultural Experiment Station, remarked on the almost complete failure of all crops on the freshly broken sawgrass muck until experiments made at the Everglades Experiment Station at Belle Glade in 1927 disclosed that proper use of copper, manganese and zinc, among other minerals, corrected this condition. This discovery of adding certain minerals to the soil made profitable crops possible without the weathering process necessary heretofore. Lloyd concluded his report with regard to the discovery, "The returns are all out of proportion to the cost and amply justify one's conviction in the great fertility of the sawgrass lands of the Everglades."[103]

After a series of further surveys and hearings in 1929 and 1930, the Army Chief of Engineers recommended on March 15, 1930, the expenditure of $9,692,000 in the Okeechobee-Caloosahatchee drainage areas for channels, levees, and other works of navigation and protection. The recommendation was conditioned on the provision that Florida or other local interests give $3,812,000 and construct a north shore levee on Lake Okeechobee together with all lands needed for operations and maintenance after the projects were finished. The Rivers and Harbors Act as passed by Congress on July 3, 1930, included the authorization to the Secretary of War to take up the work in the area as outlined above (Senate Document 115, 71st Congress, 2nd Session) with a dike 31 feet above sea level, provided Florida or other local interests contributed $2,000,000 to the project.

In the fall of 1930 the Board of Commissioners of the drainage district received a report on policy from D. Graham Copeland, chairman of a committee on policy appointed the previous January. The Copeland report gave the entire history of the Everglades drainage project from its beginning and concluded with a number of recommendations, which included the adoption of a state-wide tax to complete drainage operations, the establishment of a non-political drainage board, and the acceptance of a well-defined policy based on eminent engineering advice. The commission took no action on the report other than to have it published and made available to the public.

In 1931 the State Legislature, under the leadership of Governor Carlton, set up a new drainage board, giving true home-rule to the Everglades. According to the 1931 Act the Board of Commissioners was to consist of five men appointed, in staggered terms, by the governor from bona fide residents of the counties comprising the drainage district. The act was of little real aid to the district at that particular time as tax collections were at a virtual standstill, and the board was enjoined by court order, as a result of default on bond interest and maturity payments. In July 1932 finances of the district reached such a low stage that the board resolved to release all employees, affirm all liabilities, and express a willingness to cooperate. Affairs in the district remained at a standstill as far as state operations on the drainage works were concerned. During the 1930's several attempts were made by the successive boards to float refunding loans, but the worldwide depression prevented them from making much material progress.

Unusually low rainfall and consequent low water levels in Lake Okeechobee and the Everglades in 1931 and 1932 found many grass and muck fires throughout the Glades. The big lake fell below 11 feet and many fires which began in the summer and fall of 1931 continued to burn into June of 1932. The 1931 legislature had appropriated an emergency fund of $50,000, but many of the fires were out of control and it took the rains of the summer and fall of 1932 to extinguish them. In the annual report of the Everglades Experiment Station at Belle Glade, submitted in June of 1932, the Director called attention to the problems arising from the low water levels then prevalent. Previously the problem in the Everglades had been one of the disposition of excess waters, but with the abnormally low rainfall there had arisen the problems of irrigation and fire control. The Director of the Experiment Station suggested that the spill of Okeechobee might be diverted through the diagonal canals onto the uncultivated Glades south of the lake shore to prevent fire, conserve the soil and ameliorate the winter temperatures. The Director further advocated

[103] E. R. Lloyd, AGRICULTURAL POSSIBILITIES OF THE EVERGLADES, Senate Document 85, 71st Congress, 2nd Session, p. 13.

the adoption of a program of soil conservation in the Everglades that had been lacking heretofore due to the inadequate facilities for handling the water, a problem, made possible of solution through the Federal program of lake dikes and control canals.

From the assumption by the Federal Government of the levee and channel construction program in the Okeechobee area in 1930 to June 1939, the national government spent $18,282,530 of which $16,218,268 was for new construction and $2,064,262 for maintenance and operation. The cross-state waterway from Ft. Myers to Stuart, forming a part of the flood control project, was opened in May 1937. Various River and Harbors Acts passed since 1930 had relieved the agent of the state, the Okeechobee Flood Control District, from building the north shore levee and allowed its contributions to terminate after $500,000 had been received as the local interest's share. The Federal Government has built 85 miles of levee with an average sea level elevation of about 31 feet, storm gates at canal entrances, channels and protective works. The Government also maintains the levees and channels and exercises full control over water levels in Lake Okeechobee.

After 1932 the Everglades Drainage District hovered on the edge of bankruptcy proceedings. The bondholders enjoined the board from spending other than a one mill maintenance tax, and drainage works were at a complete stop. In June 1936 the commissioners sought a loan from the Reconstruction Finance Corporation. At that time there was $2,000,000 in past due interest coupons on outstanding bonds. In 1941 the district was benefitted by the passage of another act of the legislature which would enable the commissioners to refund or compromise the bonded debt. The act further provided for a receiver in case the bonds could not be refuned, cancelled back taxes which were unpaid and set a scale for the purchase of tax-burdened lands, thus paving the way for these lands to be once again placed in a tax-paying position. Through this act arrangements were made whereby the old bonded debt of $9,400,000, matured coupons of $3,600,000, unpaid canal construction of $1,800,000 and miscellaneous debts of $1,200,000 could be settled for a Reconstruction Finance Corporation refunding bond issue of $5,660,000.

Indicative of the growth and productiveness of the Everglades in the years from 1928 to 1938 is the progress made by the sugar industry. In 1928 13,000 tons of cane were grown which in turn produced 745 tons of raw sugar. In 1938, 663,232 tons of cane produced 65,101 tons of raw sugar. In 1938 the average sugar cane production reached 38.56 tons per acre, while that of raw sugar was 4.11 tons per acre. Beginning in 1934 federal limitations, restrictions, and prohibitions seriously affected crops after that year. Thus the sugar interests of the Everglades were paid some $500,000 for cooperating with the 1939 sugar control program, or for not growing more sugar cane.

The decade of the 1930's witnessed, among other developments, two events that may bring significant changes in the years to come. In 1934 the national congress passed an act providing for the establishment of an Everglades National Park in the southernmost end of the state. In an executive order of the same year the President ordered all public lands in the area withdrawn to await the conveyance of private lands within the proposed boundaries of the park. Should this park become a reality it would provide the only tropical park in the continental area of the United States and would prove a great asset to wildlife conservation and management as well as the promotion of another great recreation area for the state and for the nation as a whole. In 1936 the state road department obtained a right of way on the western bank of the North New River Canal for a highway from Lake Okeechobee to Fort Lauderdale and Miami. On April 12, 1941, this road was opened with a dedication ceremony. The road was named the Thomas E. Will Highway in honor of one of the real pioneers of the Everglades, who spent thirty years working for drainage and other basic improvements in the area. This new road, for better or for worse opens the heart of the Everglades to agricultural development, it also furnishes a bee-line highway to the lower east coast metropolitan areas from the lake region.

The Everglades is one of the last, if not the last, frontier to be opened in the United States. As with all frontiers, the sociology of the region has developed from the pioneer stage of "get-rich-quick" schemes to a region of substantial industry. The harvesting of the winter vegetable and sugar cane crops has caused a demand for seasonal labor. Since this work lasts less than six months, most of the field and packing house workers are migrants. Within the last few years the labor situation in the area has been the subject of publicity in regard to the squalid living conditions of many of the laborers and their families. That the Everglades have produced some of America's worst rural slums few would deny. Apologists for these conditions

advance the theories that many of the migrants live that way at home, but that when so many get together in the Glades it is more noticeable. Undoubtedly the fact that many of the planters are working leased land had much to do with little thought being given to living conditions, and the uncertainty of weather conditions upon which crop successes depend has likewise been a factor.[104] The Federal Government through the Farm Security Administration has built five migratory camps for migran. labor and many of the planter-operators have constructed houses or barracks for their individual workers. The U. S. Sugar Corporation has built a number of plantation villages to care for both field and sugar house employees and is furnishing excellent medical care, schools, commissaries and recreation. Further than this, the sugar interests have been commended for maintaining better than average agricultural wages for the continental area of the United States as well as providing good housing and other worth while innovations for the practical handling of labor in the "Deep South."

In the Everglades settlements of Canal Point, Pahokee, Belle Glade, Clewiston, Moore Haven and others, life is much the same as elsewhere in the United States with schools, churches, service clubs, modern stores and recreational features found in any small city. Throughout the area an atmosphere of optimism prevails. None want to remember the tragedies of 1926 and 1928, and few remember the trials and hardships of the pioneers of forty years ago, for as always the second and third generations reap the benefits of pioneer effort.

However, the Everglades is still facing serious and unsolved problems. The problem of soil subsidence in the highly organic peats and mucks poses questions which must be answered, for it is a common experience that soils of this type settle or compact as much as an inch a year purely as a result of drainage and cultivation. The problems of overproduction and marketing of vegetable crops are far from solved, as well as the introduction of suitable agriculture or industry that may some day use the remainder of the area that can be made available for development since the best estimate of the total area in production today do not exceed 125,000 acres. What is to be done with the remaining hundreds of thousands of acres that might be brought into production and how may they be conserved until needed? Naturally the question of soil conservation is of very great importance from the historical standpoint since if better care is not taken of cultivated soils of this type, they can not possibly endure beyond a few decades. Further than this, if better thought is not given to the present and future care of the soils of those sections that are still undeveloped, these soils certainly will not be available for development at such time as they are needed.

In all of this important question of soil and water conservation and the determining part it is to play in the future of the Everglades, there is one important asset available in this section to a degree that is to be found in few other pioneer agricultural areas of this type. Reference is to the very great admiration and respect that the Everglades farmer has for the land he is working. This springs largely from the tremendous fecundity of this black soil, which, from this standpoint, is excelled by few other soils anywhere else in the world. This conscious love of the land, more than anything else, will bind owners and tenants alike into a rigorous observance of rules, once a technical leadership has been developed which can show them what they must do if they would protect this fertile earth which they cherish so much against complete and utter destruction.

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[104] Theodore Pratt, "THE LAND OF THE JOOK," *Saturday Evening Post*, April 26, 1941; Elaine Klepper, "GLADES MIGRANT WORKERS," *Orlando* (Florida) *Sentinel-Star*, April 28, 1940.